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ABSTRACT

The Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and rigorous international study of schools and student achievement ever conducted. During the 1995 school year, the study tested the mathematics and science knowledge of a half-million students from 41 nations at five different grade levels. This report presents findings from the tests, questionnaires, and curriculum analysis performed at the fourth grade level in 26 countries and is the second of three major TIMSS reports in the "Pursuing Excellence" series. Chapters are titled "Achievement" and "Contexts of Learning". Findings include: (1) in mathematics and science, U.S. fourth graders perform above the international average of the 26 countries; (2) in mathematics content areas, U.S. fourth graders exceed the international average in five of the six areas assessed; (3) in science content areas, U.S. fourth graders' performance exceeds the international average in all four of the areas assessed; (4) the international standing of U.S. fourth graders is stronger than that of U.S. eighth graders in both mathematics and science; (5) in comparison with their international counterparts, U.S. students perform better in science than in mathematics; and (6) preliminary analysis sheds little light on factors regarding contexts of learning which might account for the differences observed. (JRH)

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ED 410 098

PURSUING EXCELLENCE

A STUDY OF U.S. FOURTH-GRADE MATHEMATICS AND SCIENCE ACHIEVEMENT IN INTERNATIONAL CONTEXT

SE 060370

INITIAL FINDINGS FROM THE
THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

OFFICE OF EDUCATIONAL RESEARCH AND IMPROVEMENT
U.S. DEPARTMENT OF EDUCATION

NCES 97-255

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Pursuing Excellence

A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context

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3

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COMMISSIONER'S STATEMENT

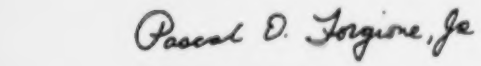
The Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international study of schools and student achievement ever conducted. This report, *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context* summarizes data on fourth-grade students in 26 countries. It is the second of three major TIMSS reports by the National Center for Education Statistics (NCES) in its *Pursuing Excellence* series. The first report, outlining U.S. comparative eighth-grade results, was released last fall, while the third report, investigating student achievement in the last year of schooling, will be published early next year. Together, these three studies will paint a more complete picture than we have ever had about how U.S. schooling practices and achievement in mathematics and science compare with the rest of the world. The information is intended to help U.S. educators, parents, policymakers, and others evaluate the strengths and weaknesses of our schools from an international perspective.

The scope of TIMSS is unprecedented in the annals of education research. The international project involved the testing of more than a half-million students in mathematics and science at three grade levels in 41 countries. In contrast to previous international comparative studies, TIMSS also goes beyond the traditional "horserace" data on student performance to analyze the content of textbooks and curricula in participating countries and to administer written questionnaires to teachers and students regarding their academic practices both inside and outside the classroom. A particularly innovative technique used at the eighth grade was the videotaping of a random sample of actual mathematics classrooms in the United States, Germany, and Japan, in order to better understand key similarities and differences in instructional practices across these three countries.

This wealth of data is being analyzed and published by NCES and others around the world. Both individually and collectively, the various TIMSS reports constitute important tools that can improve the quality of primary and secondary education for all students. That is why the Center has been working cooperatively with other parts of the U.S. Department of Education to produce a multi-media resource kit designed for educators and those interested in using TIMSS data to improve teaching, curricula, and student achievement in states and local communities.

The TIMSS data provide a reference point with which we can begin to clarify what we mean by "world-class" education. They give us tools by which we can benchmark not only the performance of our students but also the way in which we deliver instruction. Most important, they allow the U.S. to learn unique lessons from other members of the world community so that we may better pursue the goal of an excellent education for all students.

NCES is releasing the information in a variety of new forms, including CD-ROM, videotape, and the World Wide Web (http://www.ed.gov/NCES/timss). We invite everyone who is dedicated to enhancing the quality of our nation's mathematics and science education to make the fullest possible use of this rich resource.



Pascal D. Forgione, Jr.
Commissioner of Education Statistics

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EXECUTIVE SUMMARY

PREFACE

The Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international comparison of education ever undertaken. During the 1995 school year, the study tested the mathematics and science knowledge of a half-million students from 41 nations at five different grade levels. This report presents findings from the tests, questionnaires, and curriculum analysis performed at the fourth grade. Twenty-six nations participated in the fourth-grade assessment.

- TIMSS' information not only compares achievement, but also provides insights into how life in U.S. schools differs from that in other nations.

- This report on fourth-grade students is the second of a series of three public-audience reports titled *Pursuing Excellence*. The first report presented findings on student achievement at eighth grade. The third report will be released in the spring of 1998, and will present findings from the twelfth grade. Additional reports will provide information on various other topics.

TIMSS is a fair and accurate comparison of mathematics and science achievement in the participating nations. It is *not* a comparison of "all of our students with other nations' best students," a charge that some critics have leveled at previous international comparisons. The students who participated in TIMSS were randomly selected to represent all students in their respective nations, with the exception of a few nations which are clearly noted in this report. The entire assessment process was scrutinized by international technical review committees to ensure its adherence to established standards. Those nations in which irregularities arose are clearly noted in this and other TIMSS reports.

ACHIEVEMENT

One of our national goals is to be "first in the world in mathematics and science achievement by the year 2000," as President Bush and 50 governors declared in 1989. In fourth-grade science achievement, we are close to this mark. Fourth graders in only one country—Korea—outperform U.S. students in this subject.

- In mathematics, U.S. fourth graders perform above the international average of the 26 TIMSS countries. U.S. students are outperformed by those in 7 countries and outperform those in 12 countries. Among our major economic partners who participated in the study, our students' scores are below those of Japan, not significantly different from those of Canada, and are significantly higher than those of England.

- In science, U.S. fourth graders also perform above the international average of the 26 TIMSS countries. U.S. students are outperformed by students in only one country—Korea. U.S. students outperform those in 19 countries. Among our major economic partners who participated in the study, our students' scores are not significantly different from those of fourth graders in Japan. Our students outperform those in England and Canada.

- In mathematics content areas, our fourth graders exceed the international average in five of the six areas

assessed. These five areas are: whole numbers; fractions and proportionality; data representation, analysis, and probability; geometry; and patterns, relations, and functions. In one content area, the U.S. average is lower than the international average—measurement, estimation, and number sense.

- In science content areas, our fourth graders' performance exceeds the international average in all four of the areas assessed. In three of these content areas—earth science; life science; and environmental issues and the nature of science—U.S. fourth grade students are significantly outperformed by only one or two other nations. In physical science, five other nations perform significantly better than the U.S.

- If an international talent search were to select the top ten percent of all fourth-grade students in the 26 countries, in mathematics 9 percent of U.S. fourth-grade students would be included. In science, 16 percent would be included.

- The international standing of U.S. fourth graders is stronger than that of U.S. eighth graders in both mathematics and science.

- In comparison with their international counterparts, U.S. students perform better in science than in mathematics at both the fourth and eighth grades.

CONTEXTS OF LEARNING

- It is too early in the process of data analysis to provide strong evidence to suggest factors that may be related to the patterns of achievement described here. No single factor or combination of factors emerges as particularly important.

- On most background factors studied, there is no difference between the U.S. and the international average, or the differences are small. Therefore, these factors are unlikely to be strongly associated with our international standing.

- On those background factors on which there is a difference between the U.S. and the international average, the factor is not shared with most high-performing countries. Therefore, these factors are also unlikely to be strongly associated with our international standing.

- In general, preliminary analyses shed little light on factors which might account for the differences between our performance in mathematics and science, and our performance at the fourth and eighth grades. Further analyses are needed to provide more definitive insights on these subjects.

CONCLUSION

This report presents initial findings from TIMSS for fourth-grade mathematics and science, and evidence from early analyses concerning the context of U.S. education achievement. Adequate understanding of our nation's education in an international perspective must await findings from the twelfth-grade data and deeper analysis of data at all grade levels.

TIMSS is not an answer book, but a tool to examine our own national educational strengths and weaknesses in an international perspective. All countries, including the U.S., have something to learn from other nations, and have something from which other countries can learn. These TIMSS findings will be an important source of information to guide our nation in the pursuit of excellence into the next century.

PREFACE

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OVERVIEW

The Third International Mathematics and Science Study is the largest and most comprehensive comparative international study of education that has ever been undertaken. A half-million students from 41 countries were tested in 30 different languages at five different grade levels to compare their mathematics and science achievement. Intensive studies of students, teachers, schools, curriculum, instruction, and policy issues were also carried out to understand the educational context in which learning takes place.

Twenty-six countries tested fourth-grade students and made their data available for presentation. Of these, 17 met or came close to meeting all of the quality control requirements for sampling and data collection. The other 9 countries experienced difficulties of various types. All deviations from international quality control requirements are described in Appendix 4. The 9 countries within which difficulties arose are shown in parentheses both below and in figures contained in this report.

COUNTRIES PARTICIPATING IN FOURTH-GRADE TIMSS

(Australia)	Japan
(Austria)	Korea
Canada	(Kuwait)
Cyprus	(Latvia)
Czech Republic	(Netherlands)
England	New Zealand
Greece	Norway
Hong Kong	Portugal
(Hungary)	Scotland
Iceland	Singapore
Iran, Islamic Republic	(Slovenia)
Ireland	(Thailand)
(Israel)	United States

Seventeen other countries participated in one or more aspects of TIMSS but not in the fourth-grade study. These countries are Belgium (Flemish), Belgium (French), Bulgaria, Colombia, Denmark, France, Germany, Lithuania, Mexico, the Philippines, Romania, Russian Federation, Slovak Republic, South Africa, Spain, Sweden, and Switzerland.

TIMSS is an important study for those interested in U.S. education. In 1983, the National Commission on Excellence in Education pointed to our nation's low performance in international studies as evidence that we were *A Nation at Risk*. In 1989, President Bush and the governors of all 50 states adopted the National Goals for Education, one of which was that "by the year 2000, the U.S. will be first in the world in mathematics and science achievement."

Mathematics and science experts have issued major calls for reform in the teaching of their subjects. The National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards* in 1989 and *Professional Standards for Teaching Mathematics* in 1991. In 1993, the American Association for the Advancement of Science followed suit with *Benchmarks for Science Literacy*, and in 1996, the National Academy of Sciences published *National Science Education Standards*.

TIMSS helps us measure progress toward our national goal of improving our children's academic performance in mathematics and science. But TIMSS is much more than a scorecard for the mathematics and science events in the "education Olympics." It is a diagnostic tool to help us examine our nation's progress toward improvement of mathematics and science education. It was

designed to look behind the scorecard to illuminate how our education policies and practices compare with those of the world community.

This report draws from the results of the fourth-grade part of the TIMSS study to summarize the initial findings concerning mathematics and science achievement and schooling at that grade level. It is the second of three reports in the *Pursuing Excellence* series. The first report presented initial findings on the eighth grade and was released in November 1996. The third report, to be published in spring 1998, will treat findings concerning students in the twelfth grade. Other reports on selected topics will be published over the next several years. Much more will be learned as further analysis of the TIMSS data continues.

TIMSS is a fair and accurate comparison of mathematics and science achievement in the participating nations. It is *not* a comparison of "all of our students with other nations' best students," a charge that some critics have leveled at previous international comparisons. In most of the countries that participated in TIMSS, virtually all children attend elementary school, and the students who took the TIMSS test were randomly selected to represent all students in their respective nations. The entire assessment process was scrutinized by international technical review committees to ensure its adherence to established standards. Those nations in which irregularities arose are clearly noted in this and other TIMSS reports.

At each step of its development, TIMSS used careful quality control procedures. An international curriculum analysis was carried out prior to the development of the assessments to ensure that the tests reflect the mathematics and science curricula of the variety of TIMSS countries and do not overemphasize what is taught in only a few. International monitors carefully checked the test translations and visited many classrooms while the tests were being administered to make sure that the instructions were properly followed. The raw data from each country were scrutinized to be sure that no anomalies existed, and all analyses were double checked. Finally, this report has been written and carefully reviewed to avoid overgeneralization and inaccuracy.

STUDY DESIGN

TIMSS is the third comparison of mathematics and science achievement carried out by the International Association for the Evaluation of Educational Achievement (IEA). Previous IEA studies of mathematics and science were conducted for each subject separately at various times during the 1960s, 1970s, and 1980s. TIMSS is the first IEA study that has assessed both mathematics and science at the same time. Comparative studies of other subjects, including reading literacy (1992)[1] and computers in education (1993)[2] have also been published by the IEA.

TIMSS was designed to focus on students at three different stages of schooling: midway through elementary school, midway through lower secondary school, and at the end of upper secondary school. Because countries around the world set different ages at which children should begin and complete school, decisions about which students should be tested needed to take both age and grade level into account.

The populations tested are listed below. Participation in Population 2 was required of all TIMSS nations, but participation in Populations 1 and 3 was optional.

- Population 1 — Those students enrolled in the pair of adjacent grades that contained the most 9-year-olds. (Grades 3 and 4 in the U.S. and most of the world. Grades 2 and 3 or 4 and 5 in some nations.)

- Population 2 — Those students in the pair of adjacent grades that contained the most 13-year-olds at the time of testing. (Grades 7 and 8 in the U.S. and most of the world. Grades 6 and 7 in a few nations.)

- Population 3 — Those students in their final year of secondary school, whatever their age. (Grade 12 in the U.S. and most nations. Grades 9-13 in some nations.)

In all participating countries, students in both public and private schools were administered the TIMSS test. In all but a few of the TIMSS countries, virtually all Population 1 and 2 children are enrolled in school and were therefore eligible to take the test. Testing occurred 2 to 3 months before the end of the 1994-95 school year. Students with special needs and disabilities that would make it difficult for them to take the test were excused from the assessment. In each country, the test was translated into the primary language or languages of instruction. All testing in the U.S. was done in the English language.

Countries participating in TIMSS collected information primarily through assessments and questionnaires. Additional information on the content of textbooks and curriculum guides was also collected in a separate series of curriculum analyses. The 26 countries participating in the Population 1 part of the TIMSS study engaged in three types of data collection:

- Mathematics and science assessments — One and one-half hours in length, the assessments included both multiple-choice and free-response items. A smaller number of students also completed hands-on performance assessments that will be reported later.

- School, teacher, and student questionnaires — Students answered questions about their mathematics and science studies and beliefs. Teachers answered questions on their beliefs about mathematics and science and on teaching practices. School administrators answered questions about school policies and practices.

- Curriculum analysis — This exploratory study compared mathematics and science curriculum guides and textbooks. It studied subject-matter content, sequencing of topics, and expectations for student performance.

THE TIMSS RESEARCH TEAM

TIMSS was conducted by the IEA, which is a Netherlands-based organization of ministries of education and research institutions in its member countries. The IEA delegated responsibility for overall coordination and management of the TIMSS study to Professor Albert Beaton at the TIMSS International Study Center, located at Boston College. Each of the IEA member nations that

made the decision to participate in TIMSS paid for and carried out the data collection in its own country according to the international guidelines. The costs of the international coordination were paid by the National Center for Education Statistics (NCES) of the U.S. Department of Education, the National Science Foundation (NSF), and the Canadian Government.

TIMSS in the United States was also funded by NCES and NSF. Professor William Schmidt of Michigan State University was the U.S. National Research Coordinator. Policy decisions on the study were made by the U.S. National Coordinating Committee. Lois Peak of NCES monitored the international and U.S. TIMSS projects. The U.S. data collection was carried out by Westat, a private survey research firm. Trevor Williams and Nancy Caldwell were Westat project co-directors. The many advisors to the study are listed in Appendix 2.

The U.S. TIMSS team also includes the approximately 4,000 third and 7,000 fourth graders who took the assessment, and their principals and teachers in 190 schools nationwide. Their cooperation has made this report possible.

ORGANIZATION OF THIS REPORT

This report summarizes early findings from the fourth-grade data. Both third- and fourth-grade students took the TIMSS test as part of Population 1, but this initial report focuses on findings for the fourth grade. Future reports based on a more complete and extensive analysis of the data will provide deeper understanding and investigate relationships among the findings from the different parts of the study. Extensive documentation of the data collection methodologies and statistical analyses used in all participating countries is available in technical reports[3] and quality control reports[4] published by the TIMSS International Study Center at Boston College. Similar technical detail for the United States will soon be available from NCES.

This report is based on the comparative data for 26 countries published by the TIMSS International Study Center at Boston College. The report's purpose is to highlight initial findings concerning the place of the United States among the participating nations.

Chapter 1 draws from the results of the student assessments to describe U.S. student achievement in mathematics and science in comparison with their international counterparts.

Chapter 2 summarizes the evidence from initial analyses to attempt to address the key findings illuminated in Chapter 1.

CHAPTER 1: ACHIEVEMENT

KEY POINTS:

U.S. fourth graders score above average in both mathematics and science compared with the 26 nations in the TIMSS fourth-grade assessment.

U.S. students' international standing is stronger at the fourth grade than it is at the eighth grade in both mathematics and science.

U.S. students' international standing is stronger in science than it is in mathematics at both the fourth and eighth grades.

In mathematics, 9 percent of U.S. fourth graders would rank among the world's top ten percent. In science, 16 percent of U.S. fourth graders would rank among the world's top ten percent.

There is no significant gender gap in fourth-grade mathematics achievement. However, in some content areas of fourth-grade science, U.S. boys outperform U.S. girls.

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In the past, the mathematics and science achievement of U.S. students has been a cause for concern. International studies of these subjects conducted over the past 30 years show that our students have not performed as well as we might expect in comparison with their peers in other nations, especially in mathematics.

The patterns of academic achievement, however, vary widely. In a recent IEA study of reading literacy,[5] U.S. fourth graders were second only to Finland, and U.S. eighth graders ranked among the top nations. Data from the eighth-grade TIMSS study,[6] released in November 1996, showed that U.S. eighth graders score above the international average of the 41 TIMSS countries in science but below the international average in mathematics.

HOW WELL DO U.S. FOURTH GRADERS DO IN MATHEMATICS AND SCIENCE?

Compared with their international counterparts, U.S. fourth graders perform above the international average of the 26 TIMSS countries in both mathematics and science. In science, our students are outperformed by only one country—Korea.

Figures 1 and 2 on pages 20 and 21 show how U.S. students perform in these subjects.

Tempting though it may be, it is not correct to report U.S. scores by rank alone, as would be the case if one were to say U.S. fourth graders are "number x in the world in mathematics." This is because the process of calculating each country's score from the sample of students who took the test produces only an estimate of the country's score, not the true score itself. This estimate has a margin of error which is expressed as a "plus or minus" interval around the estimated score. In TIMSS, we can say with 95 percent confidence that comparisons of other countries' scores to those of the U.S. are accurate plus or minus about 15 points, depending on the design of the sample in the other countries. Comparisons of the U.S. with the international average are accurate plus or minus about 6 points. (Appendix 3 contains a list of country means and standard errors.) Because a precise score cannot be determined with perfect accuracy, to fairly compare the U.S. with other countries, nations have been grouped according to whether their performance is higher than, not significantly different from, or lower than the U.S.

In mathematics, fourth-grade students in 7 countries outperform our fourth graders (Singapore, Korea, Japan, Hong Kong, the Netherlands, the Czech Republic, and Austria). Student performance in 6 countries is not significantly different from ours (Slovenia, Ireland, Hungary, Australia, Canada, and Israel). U.S. fourth graders outperform their counterparts in 12 nations (Latvia, Scotland, England, Cyprus, Norway, New Zealand, Greece, Thailand, Portugal, Iceland, Islamic Republic of Iran, and Kuwait).

In science, students in only one country—Korea—outperform U.S. fourth graders. Student performance in 5 countries is not significantly different from ours (Japan, Austria, Australia, the Netherlands, and the Czech Republic), and U.S. fourth graders outperform their counterparts in 19 nations (England, Canada, Singapore, Slovenia, Ire-

FIGURE 1:

NATIONS' AVERAGE MATHEMATICS PERFORMANCE COMPARED WITH THE U.S.

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.	
NATION	**AVERAGE**
SINGAPORE	625
KOREA	611
JAPAN	597
HONG KONG	587
(NETHERLANDS)	577
CZECH REPUBLIC	567
(AUSTRIA)	559

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.	
NATION	**AVERAGE**
(SLOVENIA)	552
IRELAND	550
(HUNGARY)	548
(AUSTRALIA)	546
UNITED STATES	**545**
CANADA	532
(ISRAEL)	531

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S	
NATION	**AVERAGE**
(LATVIA (LSS))	525
SCOTLAND °	520
ENGLAND *°	513
CYPRUS	502
NORWAY	502
NEW ZEALAND	499
GREECE	492
(THAILAND)	490
PORTUGAL	475
ICELAND	474
IRAN, ISLAMIC REPUBLIC	429
(KUWAIT)	400

INTERNATIONAL AVERAGE = 529

SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years* Table 1.1. Boston College: Chestnut Hill, MA.

NOTES:

1. Nations not meeting international guidelines are shown in parentheses.
2. Nations in which more than ten percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted are shown with a °.
4. The international average is the average of the national averages of the 26 nations.

land, Scotland, Hong Kong, Hungary, New Zealand, Norway, Latvia, Israel, Iceland, Greece, Portugal, Cyprus, Thailand, Islamic Republic of Iran, and Kuwait).

SOME SPECIAL NOTES ON THE TEST SCORES

TIMSS is a fair comparison of achievement for several reasons. The test was jointly developed and carefully reviewed by the participating countries to ensure that the items reflected curriculum topics considered important in all countries, and did not over-emphasize the curriculum content taught in only a few. International monitors carefully reviewed nations' adherence to guidelines to ensure that significant numbers of students were not excluded from the testing process for any reason. Those nations that did exclude more than ten percent

FIGURE 2:

Nations' Average Science Performance Compared with the U.S.

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.	
NATION	**AVERAGE**
KOREA	597

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.	
NATION	**AVERAGE**
JAPAN	574
UNITED STATES	**565**
(AUSTRIA)	565
(AUSTRALIA)	562
(NETHERLANDS)	557
CZECH REPUBLIC	557

INTERNATIONAL AVERAGE = 524

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S	
NATION	**AVERAGE**
ENGLAND *°	551
CANADA	549
SINGAPORE	547
(SLOVENIA)	546
IRELAND	539
SCOTLAND °	536
HONG KONG	533
(HUNGARY)	532
NEW ZEALAND	531
NORWAY	530
(LATVIA (LSS))	512
(ISRAEL)	505
ICELAND	505
GREECE	497
PORTUGAL	480
CYPRUS	475
(THAILAND)	473
IRAN, ISLAMIC REPUBLIC	416
(KUWAIT)	401

SOURCE: Martin et al. (1997) *Science Achievement in the Primary School Years.* Table 1.1. Boston College: Chestnut Hill, MA.

NOTES:

1. Nations not meeting international guidelines are shown in parentheses.
2. Nations in which more than ten percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted are shown with a °.
4. The international average is the average of the national averages of the 26 nations.

of their students are clearly noted in this and other TIMSS reports. Therefore, we can be sure that the TIMSS scores in this report are a fair comparison of virtually all students at the appropriate grade in the various countries.

TIMSS required participating nations to adhere to extremely high technical standards at all stages of participation in the project. Of the 26 nations that participated at the fourth grade, 17 met or came close to meeting all technical standards for the study. The remaining 9 nations, however, experienced difficulties of various types. In some countries, the problems arose because a sizable proportion of schools, teachers, or students declined to participate. In others, the selection of schools or classrooms was not carried out according to international specifications. In still others, students were slightly older than the international target age. The names of

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those nations in which major difficulties arose are shown in parentheses in the figures in this report, and Appendix 4 describes the problems each encountered. Because of the problems, the same amount of confidence cannot be attached to the scores of these 9 countries as to the other 17.

When the international average is calculated only from the 17 countries that met the international specifications, the mathematics and science scores of U.S. fourth graders are still above the international average for these 17 countries. Figure 3 on page 23 shows our standing in comparison with these 17 nations.

What do the test scores mean? Due to the complex nature of the design, scoring, and analysis of the TIMSS test, a score of 600 does not mean either 600 items, or 60 percent, correct. Instead, this score indicates where the performance would fall if all fourth-grade scores were arranged along a scale running from 0 to 1,000.

In mathematics, the international average score is 529. A score of 658 or above would put a student in the top ten percent of all mathematics students in the 26 TIMSS countries, and a score of 601 would put a student in the top quarter.

In science, the international average score is 524. A score of 660 or higher would put a student in the top ten percent of all science students, and a score of 607 would put a student in the top quarter.

WHICH COUNTRIES OUTPERFORM U.S. FOURTH GRADERS IN BOTH SUBJECTS?

We can say with confidence that 5 countries outperform the U.S. in mathematics at the fourth grade (Singapore, Korea, Japan, Hong Kong, and the Czech Republic). The Netherlands and Austria also outperform us in fourth-grade mathematics, but due to deviations in their administration of TIMSS, we have less confidence in their scores. Only one nation outperforms the U.S. in science (Korea). **Therefore, at the fourth grade, only Korea outperforms the U.S. in both mathematics and science.** Four nations that outperform us in mathematics are not significantly different from us in science (Japan, Austria, the Netherlands, and the Czech Republic). Two nations that outperform the U.S. in mathematics score lower than the U.S. in science (Singapore and Hong Kong).

WHICH COUNTRIES DO U.S. FOURTH GRADERS OUTPERFORM IN BOTH SUBJECTS?

We can say with confidence that in both mathematics and science, U.S. fourth graders outperform their counterparts in 9 countries. These are:

- Seven European countries — Iceland, England, Scotland, Norway, Greece, Cyprus, and Portugal.
- Islamic Republic of Iran and New Zealand.

U.S. fourth graders also outperform Latvia, Kuwait, and Thailand in both subjects, but due to deviations in their

FIGURE 3:

Average Achievement of Nations Meeting, and Not Meeting, International Guidelines

COUNTRIES COMPLYING WITH SPECIFICATIONS		
NATION	**MATH AVERAGE**	**SCIENCE AVERAGE**
CANADA	532	549
CYPRUS	502	475
CZECH REPUBLIC	567	557
ENGLAND *°	513	551
GREECE	492	497
HONG KONG	587	533
ICELAND	474	505
IRAN, ISLAMIC REPUBLIC	429	416
IRELAND	550	539
JAPAN	597	574
KOREA	611	597
NEW ZEALAND	499	531
NORWAY	502	530
PORTUGAL	475	480
SCOTLAND °	520	536
SINGAPORE	625	547
UNITED STATES	**545**	**565**

COUNTRIES WITH LOW PARTICIPATION RATES		
NATION	**MATH AVERAGE**	**SCIENCE AVERAGE**
AUSTRALIA	546	562
AUSTRIA	559	565
LATVIA (LSS)	525	512
NETHERLANDS	577	557

COUNTRIES TESTING OLDER-THAN-SPECIFIED STUDENTS		
NATION	**MATH AVERAGE**	**SCIENCE AVERAGE**
SLOVENIA	552	546

COUNTRIES WITH NON-STANDARD SELECTION OF CLASSROOMS		
NATION	**MATH AVERAGE**	**SCIENCE AVERAGE**
HUNGARY	548	532

COUNTRIES WITH NON-STANDARD SELECTION OF CLASSROOMS AND OTHER DEPARTURES FROM GUIDELINES		
NATION	**MATH AVERAGE**	**SCIENCE AVERAGE**
ISRAEL	531	505
KUWAIT	400	401
THAILAND	490	473

MATHEMATICS INTERNATIONAL AVERAGE = 531

SCIENCE INTERNATIONAL AVERAGE = 528

SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years*. Table 1.1. Boston College: Chestnut Hill, MA and Martin et al. (1997) *Science Achievement in the Primary School Years*. Table 1.1. Boston College: Chestnut Hill, MA.

NOTES:

1. Nations in which more than ten percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
2. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted are shown with a °.
3. The international average is the average of the national averages of the 17 nations meeting international guidelines.

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administration of TIMSS, we have less confidence in their scores.

HOW DO OUR FOURTH GRADERS COMPARE WITH OUR MAJOR ECONOMIC PARTNERS?

The "Group of Seven" or G-7 countries are major U.S. economic and political allies. The other six nations in this group are Canada, France, Germany, Italy, Japan, and the United Kingdom. Italy did not administer the TIMSS test, and France and Germany did not participate in the testing of fourth-grade students. Thus the U.S. can only be compared with the United Kingdom, Canada, and Japan. The United Kingdom is made up of England, Scotland, Northern Ireland, and Wales; however, the latter two did not participate in TIMSS. England and Scotland both have the same international standing in comparison with the U.S. Therefore, in this section, we describe our standing in relation to England.

Except for Japanese students' scores in mathematics, U.S. fourth graders' mathematics and science scores are similar to or higher than those of the other three participating G-7 nations. Japanese fourth graders outperform their U.S. counterparts in mathematics. U.S. fourth graders' mathematics scores are not significantly different from those of Canada and are higher than those of England. In science, U.S. fourth graders' scores are not significantly different than those of Japan and are significantly higher than those of Canada and England.

HOW DO OUR BEST FOURTH GRADERS COMPARE WITH OTHERS' BEST?

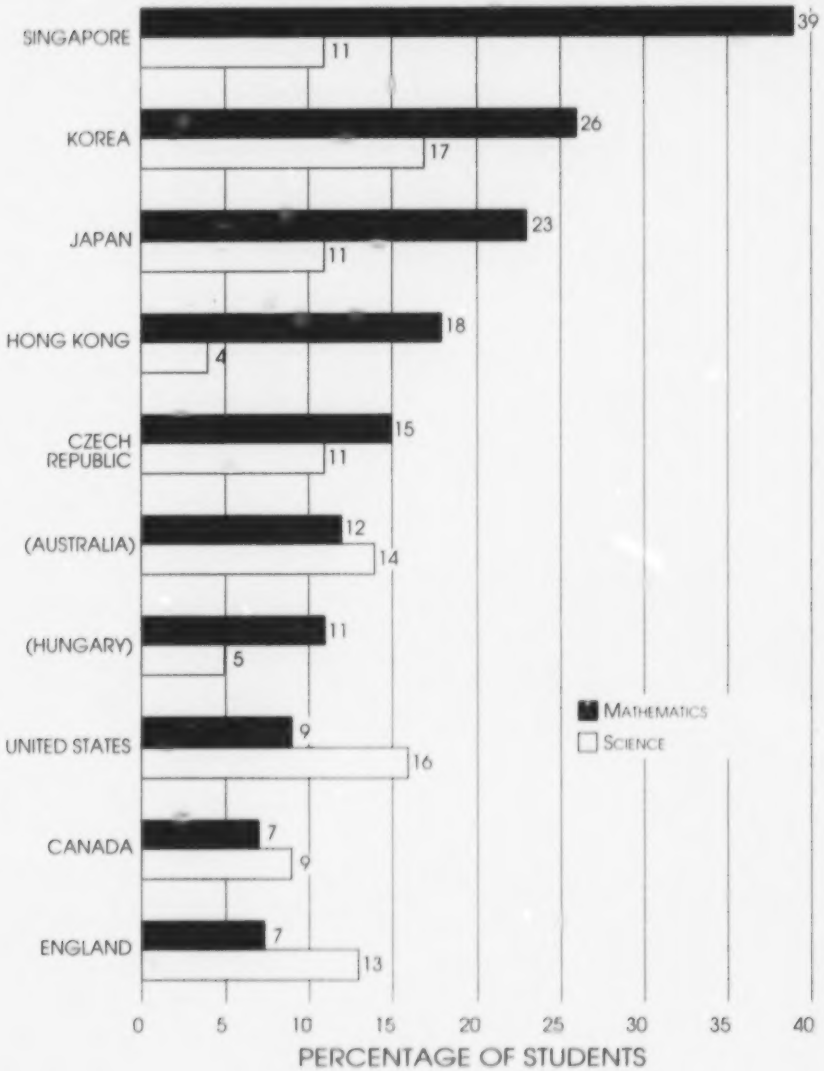
Comparisons of averages tell us how typical students perform, but they do not tell us about the performance of our nation's best students, including those who are likely to continue to study mathematics and science in secondary school and eventually become the next generation of mathematicians, scientists, doctors, and engineers. If an international talent search were to select the top ten percent of all fourth-grade students in the 26 TIMSS countries combined, what percentage of U.S. students would be included?

In mathematics, 9 percent of U.S. fourth graders are in the world's top ten percent. This is well below the 39 percent of Singaporean students, 26 percent of Korean students, and 23 percent of Japanese students who would be chosen in the international mathematics talent search. **In science, 16 percent of U.S. fourth graders would rank among the world's top ten percent.** No country has significantly more of their students in the top ten percent, and 21 nations have a smaller percentage. Figure 4 on page 25 shows results for selected countries.

If the international talent search were to lower its standards so as to choose the top half of all students in the 26 TIMSS countries, in mathematics 56 percent of U.S. fourth graders would be included. This compares with 85 percent in Korea, 82 percent in Singapore, and 79 percent in Japan. In science, 63 percent of U.S. fourth graders would be in the top half of the students in the TIMSS countries, compared with 81 percent of students in Korea and 68 percent in Japan.

FIGURE 4:

PERCENTAGE OF STUDENTS FROM SELECTED NATIONS SCORING AMONG THE TOP TEN PERCENT OF FOURTH GRADERS IN THE 26 TIMSS COUNTRIES



NOTE: Nations not meeting international guidelines are shown in parentheses.

SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years*. Table 1.4. Boston College: Chestnut Hill, MA and Martin et al. (1997) *Science Achievement in the Primary School Years*. Table 1.4. Boston College: Chestnut Hill, MA.

HOW DO OUR FOURTH GRADERS SCORE IN THE DIFFERENT CONTENT AREAS OF MATHEMATICS AND SCIENCE?

Representing student achievement in mathematics and science as a total score is a useful way to summarize achievement. Mathematics and science, however, contain very different content areas which are emphasized and sequenced differently in curricula around the world. Based on national priorities, some content areas are emphasized more than others at a particular grade level.

The TIMSS fourth-grade mathematics test included sets of items designed to sample students' ability to do work in the following areas:

- *Whole Numbers* (place value; ordering; comparing; problem-solving using addition, subtraction, and multiplication).
- *Fractions and Proportionality* (recognition and work with fractions and decimals; word problems).
- *Measurement, Estimation, and Number Sense* (common measures of size, time, temperature; rounding and estimation).
- *Data Representation, Analysis, and Probability* (use of data in charts, tables, and graphs; basic concepts underlying probability).
- *Geometry* (visualization of two- and three-dimensional forms; basic terms and properties; equivalence of figures; coordinate points on grids).
- *Patterns, Relations, and Functions* (patterns of numbers and shapes; representation of simple numerical situations; relationships of sequences of numbers).

In five of the six TIMSS mathematics content areas, the scores of U.S. fourth graders are above the international averages for those content areas. U.S. fourth-graders' performance is above the international average in whole numbers; fractions and proportionality; data representation, analysis and probability; geometry; and patterns, relations, and functions. In only one content area is the U.S. average below the international average—measurement, estimation and number sense. Figure 5 on pages 28-29 shows these results.

In science, the TIMSS fourth-grade test sampled students' ability to do work in the following subjects:

- *Earth Science* (earth features; earth processes; earth in the solar system).
- *Life Science* (structure; diversity; classification; processes; cycles; and interactions of plants and animals).
- *Physical Science* (matter; energy and physical processes; forces and motion; physical and chemical changes).
- *Environmental Issues and the Nature of Science* (environmental and resource issues; nature of scientific knowledge; interaction of science and technology).

U.S. fourth graders score above the international average in all four science content areas. In three of these content areas—earth science; life science; and environmental issues and the nature of science—U.S. fourth-grade students are outperformed by one or two other

nations. In physical science, U.S. students are outperformed by 5 other nations. Figure 6 on pages 30-31 shows these results.

IS THERE A GENDER GAP IN MATHEMATICS AND SCIENCE AT THE FOURTH GRADE?

Policymakers in the U.S. and other countries have made great efforts in recent years to make mathematics and science more accessible to girls and to encourage gender equity in these subjects. Overall, at the fourth grade, more TIMSS countries have gender equity in mathematics than in science.

The U.S. is one of 22 TIMSS nations in which there is no significant gender gap in fourth-grade mathematics achievement. For the overall science score, the U.S. is one of ten countries where a gender gap exists. Examining boys' and girls' scores in the various science content areas, U.S. boys significantly outperform U.S. girls in the content areas of earth science and physical science. There is no significant difference between U.S. boys' and girls' scores in life science and in environmental issues and the nature of science.

HAS U.S. FOURTH-GRADE INTERNATIONAL STANDING IMPROVED OVER TIME?

International comparisons over time are difficult. The first international studies of mathematics and science achievement were conducted in the 1960s, and there have been other assessments in each subject since that time. However, most assessments have focused on middle-school students and students in the final year of high school. Assessments of students in the elementary school grades have been conducted less frequently. Prior to TIMSS, only one international assessment of elementary-school children was undertaken in mathematics, although there were three prior assessments in science.

However, each assessment was done a little differently. A different set of nations participated, different topics in mathematics and science were included in the tests, the age and type of students sampled in each country changed slightly, and even the borders and names of some of the nations have changed. These and other factors complicate comparisons over time and require that any conclusions that are drawn be necessarily tentative.

Among the various international studies conducted over the past 30 years, only the International Assessment of Educational Progress (IAEP) tested the mathematics achievement of elementary-school students. In the 1991 IAEP assessment of 9-year-olds in 14 nations,[7] U.S. students scored below the international average in mathematics. However, as we have seen, in the 1995 TIMSS study reported here, U.S. fourth graders scored above the international average of 26 nations in this subject. **Comparisons over time are difficult, so caution should be exercised in assuming there has been significant improvement in our fourth graders' international standing in mathematics, but it is a possibility.**

Three previous international science assessments of elementary-school students were conducted in the 1960s, 1980s, and early 1990s. The U.S. scored above the international average in two of these three studies. In the other study,

FIGURE 5:

National Averages in Mathematics Content Areas

WHOLE NUMBERS

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
KOREA	88
SINGAPORE	83
JAPAN	82
HONG KONG	79
(HUNGARY)	76
(NETHERLANDS)	75
CZECH REPUBLIC	75
(AUSTRIA)	74
(SLOVENIA)	74

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(ISRAEL)	71
UNITED STATES	**71**
IRELAND	70
CANADA	68
(LATVIA (LSS))	68

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
(AUSTRALIA)	67 (67)
CYPRUS	65
GREECE	62
SCOTLAND *	61
NORWAY	61
ENGLAND *	58
(THAILAND)	58
PORTUGAL	57
NEW ZEALAND	57
ICELAND	56
IRAN, ISLAMIC REPUBLIC	51
(KUWAIT)	36

FRACTIONS AND PROPORTIONALITY

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	74
HONG KONG	66
JAPAN	65
KOREA	65
(NETHERLANDS)	60
IRELAND	58

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
CZECH REPUBLIC	53
(AUSTRIA)	51
(AUSTRALIA)	51
UNITED STATES	**51**
(SLOVENIA)	50
(HUNGARY)	49 (49)
CYPRUS	48
(ISRAEL)	48
CANADA	48

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
SCOTLAND *	46
ENGLAND *	45
(LATVIA (LSS))	44
(THAILAND)	44
GREECE	42
NEW ZEALAND	41
NORWAY	38
PORTUGAL	38
ICELAND	36
IRAN, ISLAMIC REPUBLIC	32
(KUWAIT)	25

MEASUREMENT, ESTIMATION, AND NUMBER SENSE

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
JAPAN	72
KOREA	72
(NETHERLANDS)	70
(AUSTRIA)	69
HONG KONG	69
CZECH REPUBLIC	68
SINGAPORE	67
(HUNGARY)	64
(SLOVENIA)	64
(LATVIA (LSS))	60
(AUSTRALIA)	60

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
IRELAND	56 (56)
NORWAY	56
CANADA	54
(ISRAEL)	54
SCOTLAND *	53
UNITED STATES	**53**
ENGLAND *	52

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
PORTUGAL	49
NEW ZEALAND	49
GREECE	48
CYPRUS	48
ICELAND	44
(THAILAND)	44
IRAN, ISLAMIC REPUBLIC	36
(KUWAIT)	35

(#) Represents International Average

NOTES:

1. Nations not meeting international guidelines are shown in parentheses.
2. Nations in which more than ten percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.

FIGURE 5 (CONTINUED):
NATIONAL AVERAGES IN MATHEMATICS CONTENT AREAS

DATA REPRESENTATION, ANALYSIS, AND PROBABILITY

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
SINGAPORE	81
KOREA	80
JAPAN	79

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
HONG KONG	76
(NETHERLANDS)	75
UNITED STATES	**73**

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
IRELAND	69
CANADA	68
(AUSTRALIA)	67
CZECH REPUBLIC	67
(AUSTRIA)	66
SCOTLAND °	66
ENGLAND *°	64
(ISRAEL)	64
(SLOVENIA)	64
NEW ZEALAND	61
(HUNGARY)	60
NORWAY	59
ICELAND	58
(THAILAND)	56
(LATVIA (LSS))	54
CYPRUS	52
GREECE	50
PORTUGAL	43
(KUWAIT)	26
IRAN, ISLAMIC REPUBLIC	23

(62)

GEOMETRY

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
HONG KONG	74
(AUSTRALIA)	74

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
ENGLAND *°	74
SCOTLAND °	72
JAPAN	72
SINGAPORE	72
KOREA	72
CANADA	72
(SLOVENIA)	72
(NETHERLANDS)	71
UNITED STATES	**71**
CZECH REPUBLIC	71

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
(AUSTRIA)	67
(LATVIA (LSS))	67
IRELAND	66
NEW ZEALAND	66
(HUNGARY)	66
ICELAND	63
(ISRAEL)	62
NORWAY	58
GREECE	53
(THAILAND)	53
CYPRUS	53
PORTUGAL	52
IRAN, ISLAMIC REPUBLIC	42
(KUWAIT)	36

(64)

PATTERNS, RELATIONS, AND FUNCTIONS

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
KOREA	83
JAPAN	76
SINGAPORE	76
HONG KONG	73

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(HUNGARY)	69
(SLOVENIA)	68
CZECH REPUBLIC	67
UNITED STATES	**66**
(LATVIA (LSS))	65
(NETHERLANDS)	65
(AUSTRIA)	64
(AUSTRALIA)	64
IRELAND	64
CANADA	62

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
(ISRAEL)	60
SCOTLAND °	57
CYPRUS	55
ENGLAND *°	55
NEW ZEALAND	52
NORWAY	50
(THAILAND)	50
ICELAND	48
PORTUGAL	47
GREECE	47
IRAN, ISLAMIC REPUBLIC	40
(KUWAIT)	33

(60)

NOTES (continued):

3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusal were substituted are shown with a °.

4. The international average is the average of the national averages of the 26 nations.

5. The placement of England in Geometry may appear out of place; however, statistically its placement is correct.

SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years*. Table 2.1. Boston College: Chestnut Hill, MA.

FIGURE 6:
National Averages in Science Content Areas

EARTH SCIENCE

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
KOREA	72
JAPAN	66

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(SLOVENIA)	64
CZECH REPUBLIC	64
UNITED STATES	**64**
(HUNGARY)	62
(AUSTRIA)	62
CANADA	62
ENGLAND *○	61
(NETHERLANDS)	61
(AUSTRALIA)	61

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
HONG KONG	61
IRELAND	60
NORWAY	60
SINGAPORE	58
SCOTLAND ○	58
NEW ZEALAND	57 (57)
(LATVIA (LSS))	57
ICELAND	55
GREECE	52
(ISRAEL)	51
PORTUGAL	50
(THAILAND)	48
CYPRUS	48
IRAN, ISLAMIC REPUBLIC	38
(KUWAIT)	36

LIFE SCIENCE

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
KOREA	76

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
JAPAN	73
(NETHERLANDS)	73
(AUSTRALIA)	72
(AUSTRIA)	72
CZECH REPUBLIC	71
UNITED STATES	**71**
SINGAPORE	70

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
CANADA	68
ENGLAND *○	68
(SLOVENIA)	68
HONG KONG	68
NORWAY	67
NEW ZEALAND	66
IRELAND	66
(HUNGARY)	66
SCOTLAND ○	65 (64)
(ISRAEL)	61
GREECE	61
(LATVIA (LSS))	60
ICELAND	60
CYPRUS	55
PORTUGAL	54
(THAILAND)	52
(KUWAIT)	45
IRAN, ISLAMIC REPUBLIC	44

PHYSICAL SCIENCE

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.

NATION	PERCENT CORRECT
KOREA	75
JAPAN	70
(NETHERLANDS)	65
SINGAPORE	64
(AUSTRIA)	64

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.

NATION	PERCENT CORRECT
(AUSTRALIA)	63
CZECH REPUBLIC	62
(SLOVENIA)	61
CANADA	61
UNITED STATES	**60**
ENGLAND *○	60
HONG KONG	60
(HUNGARY)	59

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.

NATION	PERCENT CORRECT
SCOTLAND ○	57
IRELAND	57 (57)
NEW ZEALAND	57
(ISRAEL)	55
NORWAY	55
(LATVIA (LSS))	54
ICELAND	52
CYPRUS	50
PORTUGAL	49
GREECE	49
(THAILAND)	46
IRAN, ISLAMIC REPUBLIC	40
(KUWAIT)	37

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY HIGHER THAN THE U.S.	
NATION	**PERCENT CORRECT**
KOREA	70

NATIONS WITH AVERAGE SCORES NOT SIGNIFICANTLY DIFFERENT FROM THE U.S.	
NATION	**PERCENT CORRECT**
UNITED STATES	**65**
(AUSTRALIA)	63
JAPAN	62

NATIONS WITH AVERAGE SCORES SIGNIFICANTLY LOWER THAN THE U.S.	
NATION	**PERCENT CORRECT**
(NETHERLANDS)	61
ENGLAND *[1]	56
CANADA	56
CZECH REPUBLIC	56
IRELAND	55
(SLOVENIA)	54
NEW ZEALAND	54
(AUSTRIA)	54
SINGAPORE	53
SCOTLAND [1]	53
NORWAY	53
(ISRAEL)	51 (51)
(HUNGARY)	50
HONG KONG	50
(THAILAND)	48
ICELAND	47
(LATVIA (LSS))	46
GREECE	43
CYPRUS	42
PORTUGAL	39
IRAN, ISLAMIC REPUBLIC	26
(KUWAIT)	25

(#) Represents International Average

NOTES:

1. Nations not meeting international guidelines are shown in parentheses.
2. Nations in which more than ten percent of the population was excluded from testing are shown with a *. Latvia is designated LSS because only Latvian-speaking schools were tested, which represents less than 65 percent of the population.
3. Nations in which a participation rate of 75 percent of the schools and students combined was achieved only after replacements for refusals were substituted are shown with a [1].
4. The international average is the average of the national averages of the 26 nations.
5. The placement of Hong Kong in Earth Science may appear out of place; however, statistically its placement is correct.

SOURCE: Martin et al. (1997) *Science Achievement in the Primary School Years.* Table 2.1. Boston College: Chestnut Hill, MA.

the U.S. was not different than the international average. Moreover, in all three previous studies, only a few nations outperformed the U.S. In the 1960s study, one nation out of 11 (Japan); in the 1980s study, 5 nations out of 14 (Japan, Korea, Finland, Sweden, and Hungary)[8], and in the 1991 study, one nation out of 13 (Korea) outperformed the U.S.[9] Taken together with the TIMSS findings reported here, **it appears that U.S. students in the middle years of elementary school perform reasonably well in science in comparison with their peers in other nations. It is not clear whether this relative international standing has changed over time.**

HOW DOES THE PERFORMANCE OF U.S. FOURTH GRADERS COMPARE WITH THAT OF U.S. EIGHTH GRADERS IN MATHEMATICS AND SCIENCE?

In both mathematics and science, our international standing is higher at fourth grade than it is at eighth grade. Figure 7 on page 32 provides a quick overview of mathematics and science performance at each grade level, in comparison with all of the countries participating at each grade level.

In mathematics, our fourth-grade students score above the international average, while our eighth-grade students score below the international average. In science, U.S. students score above the international average at both grade levels. However, only one nation outperforms us at the fourth grade, while 9 nations outperform us at the eighth grade.

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FIGURE 7:
U.S. Mathematics and Science Performance at a Glance

How Do U.S. Students Compare with the International Average in...?	At Grade 4? (26 nations)	At Grade 8? (41 nations)
Mathematics overall	Above	Below
Science overall	Above	Above
Mathematics Content Areas:		
Data representation, analysis, and probability	Above	Above
Geometry	Above	Below
Whole numbers	Above	x
Fractions and proportionality	Above	x
Patterns, relations, and functions	Above	x
Measurement, estimation, and number sense	Below	x
Fractions and number sense	x	Same
Algebra	x	Same
Measurement	x	Below
Proportionality	x	Below
Science Content Areas		
Earth science	Above	Above
Life science	Above	Above
Environmental issues and the nature of science	Above	Above
Physical science	Above	x
Chemistry	x	Same
Physics	x	Same

What Percentage of U.S. Students Would Be in the International Top Ten Percent In...?	At Grade 4?	At Grade 8?
Mathematics	9%	5%
Science	16%	13%

KEY:
Above = U.S. average performance higher than the average of participating nations at that grade.
Below = U.S. average performance lower than the average of participating nations at that grade.
Same = U.S. average performance not significantly different than the average of participating nations at that grade.
x = Separate content area score not reported for this grade level.

SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years.* Boston College, Chestnut Hill, MA; Martin et al. (1997) *Science Achievement in the Primary School Years.* Boston College, Chestnut Hill, MA; and U.S. Department of Education, National Center for Education Statistics.(1996). *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context.* NCES 97-198, Washington, DC: Government Printing Office.

This pattern in relative international standing is also evident when one takes into account the fact that 41 nations participated in eighth-grade TIMSS, whereas 26 nations participated in the fourth-grade study. Comparisons of U.S. total performance with the international average for the 26 nations that participated in both the fourth-grade and eighth-grade TIMSS studies confirm this observation. Among these 26 nations in mathematics, U.S. fourth graders score above the international average and are outperformed by 7 nations, whereas U.S. eighth graders score below the international average and are outperformed by 13 nations. In science, U.S. fourth graders score above the international average and are outperformed by only one other nation. U.S. eighth graders' scores are not significantly different from the international average and are lower than 8 other nations.

While the U.S. international standing is higher at fourth grade than at eighth grade, most other countries which participated in TIMSS at both grades (19 in both mathematics and science) have a similar standing relative to the international average at both grade levels. Five countries have a lower relative standing at eighth grade than at fourth grade in one subject, and 4 countries (the U.S., Scotland, Ireland, and Latvia) have a lower relative standing at eighth grade in both subjects. **Only one country—the U.S. in mathematics—falls from above the international average at fourth grade to below the international average at eighth grade.**

Another way of looking at the U.S. performance at fourth and eighth grade is to see how many countries compare more favorably to the U.S. at eighth grade than they did at fourth grade. Of the 25 other countries that participated at both grade levels, all perform as well or better relative to the U.S. at eighth grade than they do at fourth grade. That is, no country compares less favorably to the U.S. in eighth grade than it does in fourth grade, and most compare more favorably. In both subjects, most of the countries (5 out of 6 in mathematics and 4 out of 5 in science) with average scores similar to the U.S. in fourth grade have scores in eighth grade that are significantly higher than the U.S. Likewise, many of the countries (8 of 12 in mathematics and 9 of 19 in science) whose scores are below the U.S. in fourth grade have eighth-grade scores that are similar to the U.S., and in science, 3 countries (Singapore, Slovenia, and Hungary) have fourth-grade scores below the U.S. and eighth-grade scores above the U.S.

HOW DOES THE PERFORMANCE OF U.S. FOURTH GRADERS COMPARE WITH THAT OF U.S. EIGHTH GRADERS IN MATHEMATICS AND SCIENCE CONTENT AREAS?

The picture for the content areas of mathematics and science is somewhat more complicated. Figure 7 on page 32 displays the results by content area. In mathematics, the fourth-grade and eighth-grade tests have only two content areas in which scores are reported for both grade levels (data representation, analysis, and probability; and geometry). U.S. students' scores in data representation, analysis and probability are significantly higher than the international average at both grade levels. U.S. students' scores in geometry are above the international average at the fourth grade and below the average at the eighth grade.

With regard to the other mathematics content areas, U.S. fourth graders exceed the international average in three content areas (whole numbers; fractions and proportionality; and patterns, relations, and functions) but are below it in one (measurement, estimation, and number sense). Eighth graders are not different from the international average in two content areas (fractions and number sense; and algebra) and are below the international average in two areas (measurement and proportionality).

In science, the fourth-grade and eighth-grade tests have three content areas for which scores are reported at both grade levels. U.S. fourth-graders and eighth-graders' scores are higher than the international average in all three of these content areas (earth science; life science; and environmental issues and the nature of science). U.S. fourth-graders' scores are above the international average in physical science, whereas eighth-graders' scores are not different than the international average in physics and chemistry.

SUMMARY

The foregoing discussion of TIMSS achievement findings highlights three important patterns: .

- **U.S. fourth graders are above the international average in both mathematics and science.**
- **The international standing of U.S. fourth graders is stronger than that of eighth graders in both subjects.**
- **U.S. students perform better in science than in mathematics at both the fourth and eighth grades in comparison with their international counterparts.**

The next chapter explores the initial evidence from TIMSS concerning various factors that may contribute to these patterns.

CHAPTER 2: CONTEXTS OF LEARNING

KEY POINTS:

It is too early in the process of data analysis to provide strong evidence to suggest factors that may be related to the patterns of achievement described here. No single factor or combination of factors emerges as particularly important.

On most background factors studied, there is no difference between the U.S. and the international average, or the differences are small. Therefore, these factors are unlikely to be strongly associated with our international standing.

On those background factors on which there is a difference between the U.S. and the international average, the factor is not shared with most high-performing countries. Therefore, these factors are also unlikely to be strongly associated with our international standing.

In general, preliminary analyses shed little light on factors which might account for the differences between our performance in mathematics and science, and our performance at the fourth and eighth grades. Further analyses are needed to provide more definitive insights on these subjects.

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In Chapter 1, we found that U.S. fourth graders score above the international average in both mathematics and science, and that in science, our fourth-graders' average score is exceeded by only one other country. This chapter examines the early data available from TIMSS about the educational context within which our students learn for evidence that might contribute to the three major findings that:

- U.S. fourth graders score above the international average in both mathematics and science.
- The international standing of U.S. fourth graders is stronger than that of eighth graders in both subjects.
- Our students' international standing is better in science than in mathematics at both fourth and eighth grades.

The evidence presented in this chapter is not conclusive for two reasons. The first is that TIMSS questionnaire analyses are still in their early stages, and therefore much more information will be available later concerning family background, teacher beliefs about mathematics and science, and many other topics that experts believe are associated with student performance in these subjects. The second reason is that fourth-grade TIMSS lacks evidence that was available at the eighth grade from videotape and case studies from several other countries with which to supplement the questionnaires. For this reason, we do not have detailed information about classroom instruction, teacher training, students' daily lives, and other key topics in a variety of countries.

Furthermore, the TIMSS study was designed in such a way that more information was collected about mathematics than about science, and about the eighth grade than about the fourth or twelfth grade. This complicates comparisons between mathematics and science and across grade levels.

International studies have matured to the point that it is widely recognized that there is no "magic tonic" or single factor that is always present in every high-performing country and absent in every low-performing country. Indeed, education is a vast system of many interrelated parts. No single factor or easily identifiable set of factors is clearly responsible for high achievement. Furthermore, every characteristic of a high-performing country does not necessarily "cause" its high achievement.

Data on some factors such as student economic status, ethnicity, and others that are known to be associated with differences in achievement between students in the U.S. are not available for other countries. However, factors such as these cannot be an explanation for the differences in the international standing of the U.S. at the fourth grade in comparison with the eighth grade, or in mathematics in comparison with science, because the same students were tested in both subjects, and there is little difference between the economic status and ethnicity of fourth- and eighth-grade students in the U.S. This is also the case in other countries.

Definitive determination of which factors contribute to higher achievement is beyond the reach of initial analyses such as those reported here. However, such preliminary evidence can be helpful for two reasons. First, it can demonstrate which factors do not appear to be strongly related to differences in student performance. Second, it can indicate

directions in which further research might look for explanations of student performance. Therefore, let us review the currently available initial evidence concerning factors that might contribute to these three major findings.

WHAT FACTORS MIGHT CONTRIBUTE TO THE FINDING THAT U.S. FOURTH GRADERS SCORE ABOVE THE INTERNATIONAL AVERAGE IN BOTH MATHEMATICS AND SCIENCE?

Logically, if we are to suggest that any particular factor may be related to the U.S.' relatively high international standing in mathematics and science at fourth grade, then that same factor should be one on which the U.S. is significantly different from the international average in both mathematics and science. Furthermore, the factor should usually be found in other high-performing countries and not in low-performing ones.

If the pattern of evidence for a given factor does not fit both of these criteria simultaneously, logically, it is not likely to contribute strongly to the relatively high international standing of the U.S. at the fourth grade. Using these criteria for judging the evidence, the following section examines the factors for which TIMSS data are currently available to see how the educational context in which U.S. fourth graders learn differs from the international average.

HOW DOES THE U.S. FOURTH-GRADE MATHEMATICS AND SCIENCE CURRICULUM DIFFER FROM THE INTERNATIONAL AVERAGE?

When considering curriculum, a distinction should be made between the officially intended curriculum and what teachers actually teach. National, state, and local authorities, as well as publishers, set forth the officially intended curriculum in both curriculum guidelines and textbooks. Depending on the country, teachers make decisions about what to teach based more or less closely on the officially intended curriculum. What teachers actually teach their students is sometimes called the "implemented curriculum." Both the officially intended curriculum and the implemented curriculum must be considered when discussing a nation's goals for learning.

U.S. curriculum is not determined at the national level, as it is in most TIMSS countries. In 18 of the 26 countries that participated in TIMSS at the fourth grade, curriculum is primarily determined at the national level. It is primarily determined at the state level in one country, Canada. Decisions about curriculum are not centralized in the remaining 7 countries, one of which is the U.S. In many countries where curriculum decision-making is not centralized, decisions are made at the district or local level.

TIMSS studied the "intended curriculum," as set forth by state and local authorities in the approximately 40 countries that participated in the fourth-grade curriculum analysis. Experts in each country were provided with detailed lists of topics and asked to judge which topics were intended to be

taught at various grades. Examples of detailed topics in mathematics are "common fractions" and "whole number operations." Examples in science are "weather and climate" and "electricity." The number of topics intended to be taught is defined here as a measure of curricular focus. Nations in which fewer topics are intended to be taught are considered to have a more focused curriculum. Some experts believe that having fewer topics in the intended curriculum may facilitate higher student achievement by allowing the teaching of each topic in more depth.

When the judgments of the U.S. experts were compared with the international average of the approximately 40 countries, it was found that the number of topics intended for coverage in the U.S. at the fourth grade was above the international average in mathematics, and somewhat below the international average in science. In grades one, two, and three, the number of topics intended for coverage in the U.S. is above the international average in both mathematics and science. **Thus, the evidence is mixed: the U.S. fourth-grade intended curriculum is more focused in science and less focused in mathematics than the international average,** but both are less focused compared with the international average at grades one, two, and three. Therefore, greater curricular focus (or fewer intended topics) could not be a strong factor contributing to our above-average fourth-grade performance in both subjects.

At this time, we are unable to say whether or not the U.S. fourth-grade implemented curriculum is more focused than the international average. We can only compare expert judgments of the officially intended curriculum because teacher reports from the TIMSS questionnaires of what they actually teach are not yet available for any country besides the U.S.

DO U.S. FOURTH GRADERS SPEND MORE TIME IN CLASS STUDYING MATHEMATICS AND SCIENCE?

Our fourth-grade students spend more time in class per week learning mathematics and science than do their average international counterparts. U.S. fourth graders receive an average of 4.2 hours of instruction per week in mathematics. This is 18 minutes more per week than the international average of 3.9 hours. When science is taught as a separate subject, U.S. students receive an average of 2.7 hours of instruction per week, which is 48 minutes more than the international average of 1.9 hours per week. Of the countries in which fourth-grade science is taught as a separate subject, only Portugal has significantly more hours of instruction.

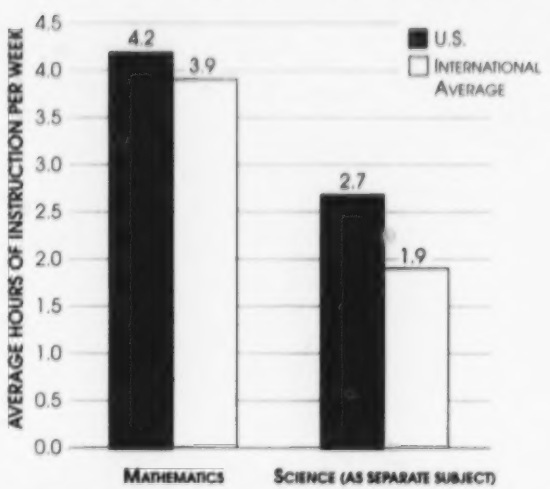
However, caution should be exercised in considering class time as a factor that might contribute to U.S. fourth graders' above-average performance in mathematics, given that 4 of the 7 nations that outperform us in mathematics spend less time in class per week than the U.S. and also less than the international average. Figure 8 on page 40 shows the comparison of U.S. weekly hours of instruction with the international averages.

IS HOMEWORK MORE COMMON IN THE U.S. THAN IN OTHER COUNTRIES?

U.S. fourth-grade teachers assign about the same amount of mathematics homework as teachers in most other countries. When teachers were asked how often they assign mathematics homework, the most common response in the majority of TIMSS countries was "three or more times a week." Teachers of 71 percent of U.S. fourth-grade students respond in this way, a figure slightly above the international average of 66 percent. Teachers of another 22 percent of U.S. students report that they assign homework once or twice a week. Figure 9 on page 41 shows these results. The percentage of U.S. fourth graders receiving mathematics homework three or more times per week is lower than 4 of the 7 countries that outperform us in mathematics, and higher than the other 3 countries that outperform us.

When asked, "If you assign homework, how many minutes do you usually assign?," teachers of most U.S. fourth graders respond "30 minutes or less," which is also the case in most other TIMSS countries. TIMSS did not ask teachers about the amount of science homework that they assign fourth-grade students.

FIGURE 8:
TEACHERS' REPORT ON AVERAGE HOURS OF MATHEMATICS AND SCIENCE INSTRUCTION PER WEEK



SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years.* Table 5.4. Boston College: Chestnut Hill, MA and Martin et al. (1997) *Science Achievement in the Primary School Years.* Table 5.5. Boston College: Chestnut Hill, MA.

HOW DOES THE STRUCTURE OF U.S. MATHEMATICS AND SCIENCE INSTRUCTION DIFFER FROM THAT IN OTHER TIMSS NATIONS?

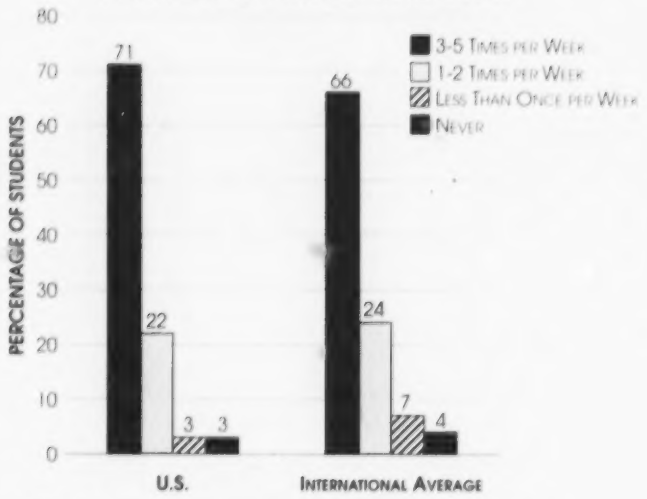
U.S. fourth graders usually study mathematics and science from the same teacher, and this is typical of fourth-grade students in most other TIMSS countries. **While three Asian countries have large class sizes of between 36 and 43 students, U.S. average class size (24) is close to the international average (25) for the other countries.** The three Asian countries with large class sizes outperform the U.S. in math, but only one of these countries outperforms us in science.

IS U.S. CLASSROOM ORGANIZATION DIFFERENT THAN THAT OF OTHER COUNTRIES?

Information about teaching collected in the fourth-grade TIMSS study is based on teacher questionnaire reports and does not provide as rich or detailed a picture as the TIMSS videotape study that was conducted in eighth-grade mathematics classrooms. However, initial analyses of the questionnaire data suggest that **organization for instruction in U.S. fourth-grade classrooms is similar to that in other countries.**

In most TIMSS countries, teachers of fourth graders report that their two most common patterns for organizing instruction used in most or every lesson

FIGURE 9:
PERCENTAGE OF STUDENTS WHOSE TEACHERS ASSIGN VARIOUS AMOUNTS OF MATHEMATICS HOMEWORK



SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years*. Table 5.19. Boston College: Chestnut Hill, MA.

in both mathematics and science is to teach the class as a whole, and to have the students work individually with assistance from the teacher. These two patterns are also the most common patterns in the U.S. in fourth-grade mathematics. Science in the U.S. is slightly different from mathematics because the second most common pattern is to have students work together as a class with students responding to each other, rather than individually with assistance from the teacher.

Teachers sometimes organize students to work in pairs, or in small groups with teacher assistance. The U.S. is close to the international average in the frequency with which teachers have students work in pairs or small groups with teacher assistance. Teachers of about one-fifth of students in the U.S. report that they use this pattern in most or every mathematics lesson and teachers of one-fourth of students use it in most or every science lesson.

ARE CALCULATORS AND COMPUTERS MORE COMMON IN U.S. FOURTH-GRADE CLASSROOMS THAN IN OTHER TIMSS COUNTRIES?

U.S. fourth graders use calculators and computers in mathematics class more frequently than do students in most other TIMSS countries. Use of calculators in U.S. fourth-grade mathematics classes is about twice the international average. In the U.S., teachers of 39 percent of the students report having students use calculators in their mathematics classes at least once or twice a week compared with the international average of 18 percent. Internationally, the teachers of two-thirds of the TIMSS students report that they never or hardly ever have students use calculators in their mathematics classes compared with the teachers of one-third of U.S. students. **In 6 of the 7 nations that outscore the U.S. in mathematics, teachers of 85 percent or more of the students report that students never use calculators in class.**

Among the 26 countries that participated in fourth-grade TIMSS, teachers in the U.S. and Canada are among the most likely to report that students use computers in at least some mathematics lessons. Teachers of 37 percent of the U.S. students report that computers are used in at least some lessons, in comparison with 15 percent of students internationally. Teachers in 5 of the 7 countries that outscore the U.S. in mathematics report that they never or almost never have students use computers in mathematics lessons.

In all countries, fourth-grade students were not allowed to use calculators or computers when taking the TIMSS test.

ARE U.S. FOURTH-GRADE TEACHERS BETTER TRAINED THAN THEIR COLLEAGUES IN OTHER TIMSS COUNTRIES?

The profile of a typical U.S. teacher of fourth graders is similar to that of teachers in most other TIMSS countries: a woman at least 40 years old with more than 10 years of teaching experience. However, **teachers of U.S. fourth graders have more university training than their counterparts in most TIMSS countries.** This is because the U.S. is one of only 10 of the 26 nations that participated in

TIMSS at the fourth grade that requires elementary school teachers to earn a university degree before being certified to teach. This university degree typically requires 4 years. Thirteen TIMSS countries require a degree from a non-university teacher-training institution, which usually requires 3 years to complete. Three nations certify teachers from either universities or teacher training institutions. **Among the 7 countries that outperform the U.S. in fourth-grade mathematics, 3 countries require a university degree and the other 4 countries require a degree from a 3-year teacher-training institution.** Almost all TIMSS countries, including the U.S., require some period of teaching or practice experience, as well as an evaluation or examination of the teacher before full teacher certification is granted.

U.S. fourth-grade teachers meet with other teachers to discuss curriculum about as frequently as their colleagues in other TIMSS countries. Mathematics teachers of about 60 percent of U.S. students report that they meet at least once a week with other teachers in their subject area to discuss and plan curriculum or teaching approaches; the same is true in science. About 40 percent say they meet less frequently. Teachers in many other TIMSS countries report meeting with similar frequency.

DO U.S. TEACHERS EXPERIENCE FEWER PROFESSIONAL CHALLENGES THAN DO TEACHERS IN OTHER TIMSS COUNTRIES?

U.S. teachers' perceptions of their professional challenges are similar to but possibly less limiting than teachers in most of the 26 TIMSS countries. Teachers of fourth graders in most TIMSS countries, including the U.S., most frequently cite varying academic abilities of students, and a high student-teacher ratio as factors that limit how they teach their class either "quite a lot" or "a great deal." The next most frequent challenges are shortages of equipment for use in demonstrations and other exercises, and disruptive students. However, teachers of a smaller percentage of U.S. students report that these factors limit how they teach their classes than the international average. Figure 10 on page 44 shows that the U.S. is below the international average with respect to all four of these challenges, including classroom discipline. It is important to remember, however, that this information represents teachers' subjective impressions rather than actual measures of the classroom environment in the various countries.

DO U.S. STUDENTS HAVE MORE EDUCATIONAL RESOURCES IN THEIR HOMES THAN DO TYPICAL STUDENTS IN OTHER TIMSS COUNTRIES?

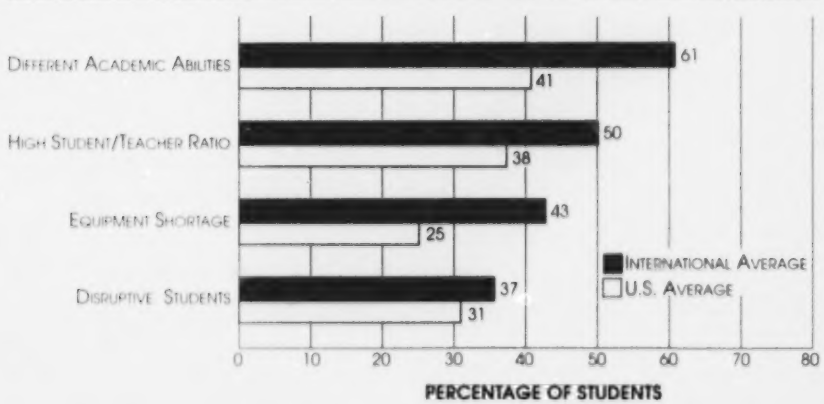
Experts believe that homes that have books, a desk in a quiet place for study, a dictionary, a computer, and other educational resources provide an environment that fosters academic development. **U.S. fourth graders have more educational resources in their homes than the average student in other TIMSS countries, but this is not true of most other high-performing countries.** About one-half of U.S. fourth graders report that they have three key resources in their home: a dictionary, their own study desk, and a computer, compared with about one-third of students in the 26

TIMSS countries. A smaller percentage of fourth graders in 4 of the 7 countries that outperform us in mathematics and the one country that outperforms the U.S. in science report having all three of these educational resources in their homes than in the U.S. Of the other 3 countries that outperform the U.S. in mathematics, in one country, the percentage is about the same as the U.S., in another country the percentage is larger, and in another nation the students were not asked this question.

Fifty-six percent of U.S. fourth graders report having at least 100 books in their homes, which is greater than the international average of 42 percent. A smaller percentage of students in 3 of the 7 nations that outperform us in mathematics report having more than 100 books, and about the same percentage report having at least this many books in the 3 other nations. One nation did not ask its students this question.

Computers are more common in the homes of U.S. fourth graders than the international average, but the U.S. does not lead the world in this respect. In the U.S., 56 percent of fourth graders report having a computer at home, compared with the international average of 49 percent. In 5 countries, 75 percent or more of fourth graders report having a computer at home: Scotland, England, the Netherlands, Iceland, and Ireland. Only one of these nations (the Netherlands) outscores the U.S. in mathematics and none in science. **In 4 of the 7 nations that outscore the U.S. in mathematics, fewer students report having a computer at home than do students in the U.S.**

FIGURE 10:
PERCENTAGE OF MATHEMATICS STUDENTS WHOSE TEACHERS REPORT VARIOUS CIRCUMSTANCES LIMIT THEIR TEACHING 'QUITE A LOT' OR 'A GREAT DEAL'



SOURCE: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years.* Figure 5.4. Boston College: Chestnut Hill, MA.

DO U.S. FOURTH GRADERS HAVE MORE POSITIVE ATTITUDES TOWARD MATHEMATICS AND SCIENCE THAN DO STUDENTS IN OTHER COUNTRIES?

More U.S. fourth graders believe it is important to do well in math and science and have confidence about their performance in these subjects than their international counterparts.

Over 90 percent of students in most TIMSS countries believe that it is important to do well in mathematics and science. U.S. students are even more likely to agree that it is important to do well in these subjects. In the U.S., virtually all fourth graders think it is important to do well: 98 percent believe it is important to do well in mathematics, and 97 percent believe it is important to do well in science.

A large majority of fourth graders in the U.S. have confidence that they are doing well in mathematics and science, and this is the case in other countries as well. Ninety-one percent of U.S. fourth graders either agree or strongly agree that they are doing well in mathematics and science. In both mathematics and science, U.S. fourth graders are more likely than the international average to strongly agree that they are doing well in these subjects.

Fourth graders in the U.S. report they like both mathematics and science, and the percentage who report this is about the same as the average of all TIMSS students. In the U.S., 84 percent of fourth graders report that they either "like" mathematics or like mathematics "a lot." In science, this proportion is 85 percent.

IS HEAVY TELEVISION WATCHING LESS COMMON AMONG U.S. FOURTH GRADERS THAN AMONG STUDENTS IN OTHER COUNTRIES?

More U.S. fourth graders watch large amounts of TV than the international average. Thirty-two percent of U.S. students report watching three hours or more of television on a normal school day. This is higher than the international average of 25 percent of students who report watching this much. In 4 of the 7 nations that outperform us in mathematics, the percentage of students who report watching three or more hours of television per night is smaller than the international average. In one nation, the percentage is about the same as the international average, and in one it is larger. One nation did not ask this question of its students.

SUMMARY

Let us return to the question with which this section started: "What factors might contribute to the finding that U.S. fourth graders score above the international average in both mathematics and science?" We have examined the early evidence from the TIMSS questionnaires about how various factors related to our fourth-grade education in general, and our mathematics and science education in particular, differ from the international average. We have also examined whether or not these differences are also characteristic of most high-performing countries. It is unlikely that any of the factors described in this chapter, when considered in isolation, contribute strongly to U.S. performance for two reasons. First, on most of the

background factors studied, there is no difference between the U.S. and the international average, or the differences are small. Second, on those factors on which there is a difference between the U.S. and the international average, the factor is not shared with most high-performing countries.

Rather than considering single factors in isolation, it is possible that the combined effect of several factors creates an educational environment that nurtures U.S. above-average performance. Caution should be exercised, however, in assuming that this is the case because most of the characteristics of U.S. fourth-grade education also characterize U.S. eighth-grade education, and at the eighth grade, U.S. students score below the international average in mathematics.

There may be other important factors about U.S. education that contribute to our above-average performance at the fourth-grade level that were not measured by the TIMSS study. There also are likely to be factors that were measured by the TIMSS study but have not yet been fully analyzed that will provide more information about what contributes to our students' above-average performance at this grade level.

Even though differences from the international average may not appear to have a strong relationship to our international performance, understanding such differences helps us view the context of U.S. education in comparative perspective. Therefore, let us summarize the initial questionnaire findings about how U.S. fourth-grade mathematics and science education differs from the international average.

- Curriculum is not determined at the national level in the U.S., as it is in most TIMSS countries.
- Students in the U.S. spend more class time per week studying mathematics and science than the international average.
- Teachers in the U.S. assign about the same amount of mathematics homework as teachers in other TIMSS countries.
- Students in the U.S. use calculators and computers in mathematics class more often than do students in most other TIMSS countries.
- Teachers in the U.S. have more university training than do their colleagues in many other TIMSS countries.
- U.S. teachers' professional challenges are perceived to be similar to, but possibly less limiting than, those experienced by teachers in other TIMSS countries.
- Students in the U.S. have more educational resources in their homes than the international average.
- More U.S. students believe it is important to do well in mathematics and science, and have more confidence about their performance in these subjects, than their average international counterpart.
- More U.S. fourth graders watch large amounts of TV than their international counterparts.

WHAT FACTORS MIGHT CONTRIBUTE TO THE FINDING THAT THE INTERNATIONAL STANDING OF U.S. FOURTH GRADERS IS STRONGER THAN THAT OF U.S. EIGHTH GRADERS?

In Chapter 1, we have seen that in both mathematics and science our students' international standing is higher at the fourth grade than it is at the eighth grade. In mathematics, among the 26 nations that participated at the fourth grade, our students' total test scores are above the international average whereas our eighth-graders' scores are below the international average of the 41 nations that participated at this grade level. In science, our students score above the international average for the 26 nations at the fourth grade and the 41 nations at the eighth grade. However, comparing our performance with the 26 nations that participated at both grade levels, whereas one nation outperforms us at the fourth grade, 8 nations outperform us at the eighth grade. The pattern of U.S. younger students performing relatively better compared with their international peers is not unique to TIMSS. It is a pattern that has been observed in most previous international assessments in mathematics, science, and reading.[10]

Later analyses will allow more in-depth study of our students' better international standing at the fourth grade than at the eighth grade. At the time of these initial analyses, identical data are not available for some factors at both the fourth and eighth grades, and for both mathematics and science. Further data analysis will allow expanded investigation of these questions. In addition, some of the explanations may lie with factors that occur prior to the fourth grade or occur in the grades between fourth and eighth, for which there are little TIMSS data.

The following section examines the initial evidence about factors that might contribute to the international standing of our fourth graders being stronger than that of our eighth graders. Logically, for a factor to be strongly related to our better international performance at the fourth grade, it should be present in different amounts at the fourth and eighth grades relative to the international average, and this difference should be found in both subjects.

For example, to consider the amount of homework that U.S. students are assigned as an important factor contributing to differences in performance between the two grades, two pieces of evidence are desirable. First, the amount of homework fourth graders receive should be higher relative to the the international average at the fourth grade than it is at the eighth grade. Second, this should be the case in both mathematics and science. Using these criteria for judging the evidence, the following section examines the early TIMSS data available at this time.

IS THE U.S. FOURTH-GRADE CURRICULUM MORE FOCUSED THAN THAT OF THE EIGHTH GRADE?

Comparing expert judgments of the officially intended mathematics curriculum, there does not appear to be much difference between the fourth grade and the eighth grade. The number of mathematics topics judged as intended

by experts is substantially above the international average at both grade levels. In science, the number of topics experts judged to be intended is slightly below the international average at the fourth grade and somewhat above at the eighth grade. If focus is defined as a smaller number of intended topics, **the evidence concerning the intended curriculum is mixed: in mathematics, there is little difference in the amount of focus relative to the international average between fourth and eighth grade. In science, the fourth-grade curriculum may be more focused than the eighth-grade curriculum, relative to the other TIMSS countries.** If the full span of grades from first to eighth is examined, the U.S. intended curriculum contains more topics than the international average at every grade in both subjects, except for fourth-grade science.

To learn about the implemented curriculum, or what is actually taught, teachers in the 26 nations that participated in fourth-grade TIMSS were given lists of broad categories of subject matter, referred to here as "topic areas." Examples of topic areas in mathematics are "whole numbers," and "fractions and decimals," and in science are "earth features" and "matter." Teachers were asked to check off those topic areas that they had already taught their fourth graders that year or planned to teach them before the school year ended in order to provide an estimate of teaching coverage for the whole year. At this time, only U.S. data are available on the implemented curriculum. Therefore, we can compare the differences between the fourth and eighth grades in the U.S., but we cannot tell how relatively focused the U.S. curriculum is compared to other countries.

In mathematics, on average, U.S. fourth graders are taught 14 out of 20 topic areas, and eighth graders are taught 16 out of 21 topic areas. In science, on average, U.S. fourth graders are taught 16 out of 22 topic areas, and eighth graders are taught 14 out of 22 topic areas.

ARE U.S. FOURTH GRADERS ASSIGNED RELATIVELY MORE MATHEMATICS HOMEWORK THAN ARE U.S. EIGHTH GRADERS?

U.S. fourth graders are less frequently assigned mathematics homework than are eighth graders, but the frequency of homework is higher than the international average in both grades. According to teacher reports, 71 percent of U.S. fourth graders and 86 percent of U.S. eighth graders are assigned mathematics homework three or more times per week. These percentages of students are greater than the international average for the fourth and eighth grades.

IS U.S. FOURTH-GRADE MATHEMATICS AND SCIENCE INSTRUCTION DIFFERENT FROM THAT IN THE EIGHTH GRADE?

U.S. fourth graders usually study mathematics and science from the same teacher, and eighth graders usually study it from different teachers, which is also true for the majority of students in most other TIMSS countries.

Mathematics class sizes in U.S. fourth and eighth grades are approximately equal and are not far from the international average for both grade levels.

Except for a few Asian countries with very large classes, U.S. class sizes are quite similar to the average of the rest of the countries at both grade levels.

IS U.S. FOURTH-GRADE MATHEMATICS CLASSROOM ORGANIZATION DIFFERENT FROM THAT IN THE EIGHTH GRADE?

Teachers of fourth- and eighth-grade students report similar patterns of organization in their mathematics classes, and at both grade levels these are comparable with the international averages. At both grade levels, in most or every lesson, the most common pattern of mathematics instruction is for the teacher to teach the whole class, or to have students work individually with assistance from the teacher during at least some part of most lessons.

ARE CALCULATORS USED MORE COMMONLY IN U.S. FOURTH-GRADE MATHEMATICS CLASSES THAN IN EIGHTH-GRADE CLASSES?

U.S. fourth graders use calculators less frequently in mathematics classes than do U.S. eighth graders. Teachers of 39 percent of U.S. fourth graders report that students use calculators in mathematics class at least once or twice a week, in comparison with 82 percent of eighth graders. At both grade levels, teachers of U.S. students are more likely to report that they have students who use calculators in class than the international average.

ARE U.S. FOURTH-GRADE TEACHERS MORE EXPERIENCED THAN EIGHTH-GRADE TEACHERS?

In mathematics, there is little difference between the fourth and eighth grades in the percentage of students whose teachers have more than 10 years of experience. In science, more fourth-grade teachers than eighth-grade teachers have this much experience. In mathematics, teachers of 62 percent of students at both grade levels have more than 10 years of teaching experience. In science, teachers of 62 percent of fourth-grade students and 52 percent of eighth-grade students have more than 10 years of experience. These percentages are close to the international average for fourth- and eighth-grade mathematics and fourth-grade science. For science, the percentage of U.S. eighth-grade students whose teachers have more than ten years of experience is less than the international average.

DO U.S. FOURTH-GRADE STUDENTS HAVE MORE EDUCATIONAL RESOURCES IN THEIR HOMES THAN DO EIGHTH GRADERS?

Fewer U.S. fourth graders have their own study desk, a computer, and a dictionary at home than do eighth graders, but the percentage of U.S. students who have all three of these study aids at home is larger than the international average at both grade levels. At the fourth grade, 49 percent of U.S. students have all three study aids, and at the eighth grade, 56 percent report having all three.

The percentage of students who report having a computer at home, and the percentage who report having at least three bookcases filled with books (or at least 200 books) at home is about the same for both grade levels, and both of these percentages are above the international averages.

DO U.S. FOURTH-GRADE STUDENTS WATCH RELATIVELY LESS TV THAN EIGHTH-GRADE STUDENTS?

U.S. students watch more hours of TV in both fourth and eighth grades than the international average.

DO U.S. FOURTH GRADERS LIKE MATHEMATICS AND SCIENCE MORE THAN DO U.S. EIGHTH GRADERS?

A majority of U.S. fourth and eighth graders report that they like both mathematics and science, but more fourth graders report liking these subjects than do eighth graders. In mathematics, 84 percent of fourth graders say that they "like" mathematics or "like it a lot," compared with 71 percent of eighth graders. In science, 85 percent of U.S. fourth graders say that they like the subject or like it a lot compared with 71 percent of eighth graders. These percentages are close to the international averages for fourth- and eighth-grade science and fourth-grade mathematics. For mathematics, the percentage of U.S. eighth graders who like mathematics or like it a lot is above the international average.

SUMMARY

None of the factors among those considered appear to strongly contribute to the better international standing of U.S. fourth graders in comparison with U.S. eighth graders in both subjects. Among the factors for which we have comparable data at both grades, some factors exhibit little or no difference between fourth and eighth grades or the pattern of evidence is mixed. In fact, each of the differences in the U.S. between the fourth and eighth grades listed below is typical of most other TIMSS countries and is also typical of the international averages for these two grade levels. For some factors, such as homework, in-class calculator use, and possession of study aids in the home, U.S. fourth graders have less of these factors than do U.S. eighth graders. However, compared with the international average on these factors, there is no difference in the U.S. standing between the fourth and eighth grades. Therefore, **evidence concerning why the international standing of U.S. fourth graders is stronger than that of eighth graders is inconclusive and incomplete. Further analyses will possibly shed more light on this question.**

To review the initial findings presented here concerning the differences between fourth grade and eighth grade:

- While U.S. fourth graders are less frequently assigned mathematics homework than are eighth graders, both are above the international average.

- In the U.S., as well as other TIMSS countries, fourth graders usually study mathematics and science from the same teacher, and eighth graders study it from different teachers. U.S. eighth graders are less likely to have

science teachers with more than ten years of experience than are U.S. fourth graders.

- U.S. fourth graders use calculators in mathematics classes less frequently than do eighth graders and both are above the international average.

- While fewer U.S. fourth graders have their own study desk, computer, and dictionary at home than eighth graders, the percentages are higher than the international average at both grades.

- U.S. fourth graders report that they like mathematics and science more than eighth graders, but only U.S. eighth graders in mathematics exceed the international average.

None of these factors, either in isolation or in combination, appear to contribute heavily to the relative difference between U.S. fourth- and eighth-grade performance.

WHAT FACTORS MIGHT CONTRIBUTE TO THE FINDING THAT THE INTERNATIONAL STANDING OF U.S. STUDENTS IS STRONGER IN SCIENCE THAN IN MATHEMATICS?

In Chapter 1, we have seen that at both the fourth and eighth grades, our international standing is stronger in science than it is in mathematics. In science, our students are above the international average at both grade levels. Among the 26 nations that participated in TIMSS at both the fourth and eighth grades, only one nation outperforms us in science at the fourth grade, and 8 nations outperform us at the eighth grade. In mathematics, our students are above the international average at the fourth grade and below it at the eighth grade. Seven nations outperform us in mathematics at the fourth grade and 13 nations outperform us at the eighth grade.

Logically, if we are to suggest that any particular factor may be related to our students' stronger international standing in science than in mathematics, that factor should be present in different amounts in mathematics and science, relative to the international average. This difference should also be found at both the fourth and eighth grades.

Further analyses will allow more in-depth investigation of these questions. Based on the data available at this time, it is not always possible to compare background characteristics of U.S. eighth-grade education to the international average. Currently available TIMSS data allow within-U.S. comparison of differences between fourth-grade mathematics and science for only a few background factors. At the time of these initial analyses, comparable analyses of the data for the eighth grade have not been conducted. Later analyses will allow for much deeper investigation of these subjects.

IS THE U.S. CURRICULUM MORE FOCUSED IN SCIENCE THAN IN MATHEMATICS?

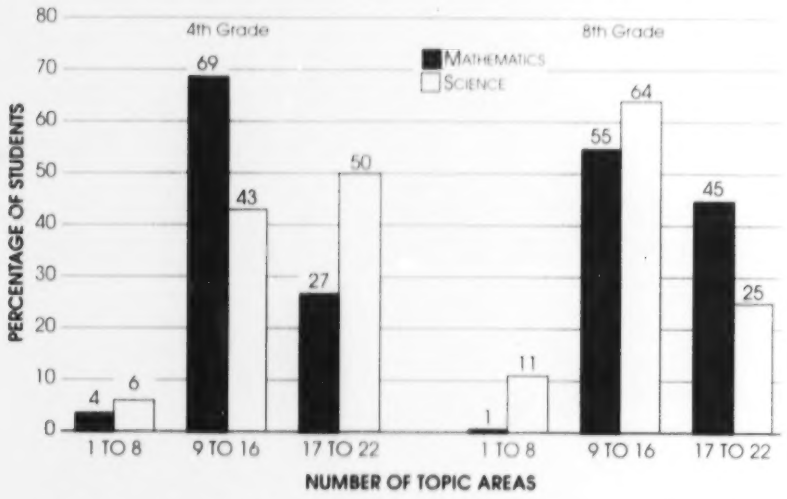
In mathematics, according to expert judgment concerning the number of topics officially intended in mathematics, the U.S. intended curriculum includes more topics than the interna-

tional average at both the grades, fourth and eighth. In science, the number of topics in the U.S. intended curriculum is somewhat below the international average at grade 4, and close to the international average at grade 8. If all grade levels between one and eight are examined, science appears closer to the international average than mathematics. Thus, the U.S. intended curriculum may be more focused in science than in mathematics.

When asked what they actually teach, teachers of 73 percent of U.S. fourth-grade students report teaching fewer than 17 mathematics topic areas per year. In science, the comparable figure is 50 percent. At the eighth grade, mathematics teachers of 55 percent of U.S. students teach less than 17 topics per year, in comparison to science teachers of 75 percent of U.S. students. Figure 11, below, shows these findings. At this time, only U.S. data are available on the implemented curriculum. Therefore, we cannot compare these U.S. findings to those of other countries.

In summary, **evidence concerning curriculum focus is mixed. Relative to other countries, the U.S. intended curriculum is more focused in science than in mathematics at both the fourth and eighth grades.**

FIGURE 11:
PERCENTAGE OF FOURTH- AND EIGHTH-GRADE STUDENTS WHOSE TEACHERS REPORT TEACHING VARIOUS NUMBERS OF MATHEMATICS AND SCIENCE TOPICS



SOURCE: Third International Mathematics and Science Study teacher questionnaires; unpublished tabulations by Michigan State University and Westat.

DO U.S. STUDENTS SPEND RELATIVELY MORE TIME IN CLASS STUDYING SCIENCE THAN MATHEMATICS?

As described above, U.S. fourth graders spend more time in class per week studying mathematics than studying science. In mathematics, U.S. fourth graders receive 4.2 hours per week of instruction and 2.7 hours per week in science. In both subjects, U.S. fourth graders receive more instruction per week than the international average. However, **relative to the international average, U.S. fourth graders receive considerably more additional science instruction than mathematics instruction.** U.S. fourth graders receive 48 minutes more science instruction per week than the international average, and 18 minutes more mathematics instruction per week than the international average.

Initial analyses do not provide comparable information for the eighth grade in both subjects, nor do they provide an estimate of total amount of class time per year, taking into account the number of weeks in the school year.

ARE CLASS SIZES DIFFERENT IN SCIENCE THAN IN MATHEMATICS?

At the fourth grade, there is usually no difference between class sizes in mathematics and science because most students in the U.S. and in the majority of TIMSS countries study mathematics and science in the same class from the same teacher.

ARE U.S. SCIENCE TEACHERS MORE EXPERIENCED THAN MATHEMATICS TEACHERS?

Evidence concerning teacher experience is mixed. Both absolutely, and compared with the international average, U.S. eighth graders are less likely to have teachers with more than 10 years of experience in science than in mathematics. In the U.S., 52 percent of eighth-grade students have science teachers with more than 10 years of experience, compared with the international average of 62 percent. In mathematics, 62 percent of U.S. students have teachers with more than 10 years of experience, which is not significantly different from the international average.

At the fourth grade, in the U.S. and most countries, mathematics teachers have the same amount of teaching experience as science teachers because the same teacher teaches both subjects.

ARE U.S. STUDENT ATTITUDES MORE POSITIVE TOWARD SCIENCE THAN THEY ARE TOWARD MATHEMATICS?

Approximately equal percentages of U.S. students have positive attitudes toward mathematics as have positive attitudes toward science. In both subjects, at both the fourth and eighth grades, a majority of students report that they like these subjects and feel that they usually do well in them. In both subjects, the percentage of U.S. students who express positive attitudes is similar to the international average except in eighth-grade mathematics where the percentage of U.S. students who like the subject is above the international average.

SUMMARY

Evidence concerning why the international standing of U.S. students is stronger in science than in mathematics is inconclusive and incomplete. Further analyses will shed more light on this question. For most of the factors for which data are currently available, there is no difference between mathematics and science, or evidence from the fourth and eighth grades is mixed. The only factor among those reviewed here that exhibits a difference between mathematics and science is:

- Compared with the international average, U.S. fourth graders receive considerably more additional instruction per week in science than in mathematics.

However, it is not clear if this difference is also characteristic of the eighth grade, or if it represents more total class time per year. Therefore, caution should be used in assuming that it contributes strongly to U.S. students' stronger performance in science than in mathematics.

CONCLUSIONS

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This report has presented highlights from initial analyses of the academic performance of U.S. fourth graders in comparison with countries that participated in the TIMSS fourth-grade study. The report has also presented the evidence available from early analyses concerning why U.S. students perform above the international average at the fourth grade, and why their comparative international standing is stronger at the fourth grade than at the eighth grade, and stronger in science than in mathematics. Adequate understanding of the answers to these questions must await deeper analysis.

TIMSS does not suggest any single factor or combination of factors that leads to high academic performance in every country. If anything, TIMSS suggests that there may be multiple recipes for excellence and that different combinations of factors may contribute to high achievement in different countries. There are no educational characteristics that are present in every high-performing TIMSS country.

Although the evidence presented in this report does not point to any factors that are strongly related to high achievement, the evidence does suggest that some factors commonly thought to be related are not necessarily so. For example, more time in class, more homework, less television, and smaller class sizes have often been thought to be strongly related to higher achievement. The TIMSS evidence presented here shows that these factors are not necessarily characteristic of most high-performing countries, and also that they cannot explain the difference between our nation's relative international standing at the fourth and eighth grades, and in science and mathematics.

International comparisons have matured to the point where we no longer search for single factors that always produce world-class performance. Instead, we need to use these findings as an objective assessment of the strengths and weaknesses characteristic of each specific national education system. All countries, including the U.S., have something to learn from other nations, and have something from which other countries can learn. TIMSS allows us to examine our own national educational strengths and weaknesses in the mirror of other nations.

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APPENDIX 1
ADDITIONAL TIMSS REPORTS

WHERE CAN I FIND A GOOD SUMMARY OF TIMSS FINDINGS THAT PUTS U.S. EDUCATION IN COMPARATIVE PERSPECTIVE?

***Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context*, November 1996—This report draws from the assessments, surveys, video, and case studies of TIMSS to summarize the most important findings concerning U.S. achievement and schooling in the eighth grade. Paperback, 80 pp. $9.50.**

To order, contact: U.S. Government Bookstore Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; E-mail: bybsys@access.digex.net; Internet: http://www.access.gpo.gov/su_docs. GPO #065-000-00959-5. Also may be downloaded from http://www.ed.gov/NCES/timss.

***Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*—This report summarizes the most important findings concerning U.S. achievement and schooling in the fourth grade. Paperback.**

To order, contact: U.S. Government Bookstore Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; E-mail: bybsys@access.digex.net; Internet: http://www.access.gpo.gov/su_docs. NCES 97-255. Also may be downloaded from: http://www.ed.gov/NCES/timss.

***TIMSS: A Video Report*, February 1997—This video summarizes the TIMSS' key findings concerning U.S. eighth-grade education and includes the views of business leaders, policymakers, educators, and researchers on the study's implications for America's schools. 13 minutes. $20.**

To order, contact: U.S. Government Bookstore Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; E-mail: bybsys@access.digex.net; Internet: http://www.access.gpo.gov/su_docs. GPO #065-000-01003-8.

***Highlights of Results from TIMSS*, November 1996—Glossy brochure, 8 pp.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu.

***Web Sites*—There are several web sites devoted to TIMSS. For general information about the study as well as direct access to many TIMSS publications, please see:**

http://www.ed.gov/NCES/timss
http://wwwcsteep.bc.edu/timss
http://uttou2.to.utwente.nl/
http://ustimss.msu.edu/

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WHERE CAN I FIND A DETAILED INTERNATIONAL COMPARISON OF EIGHTH-GRADE STUDENTS?

***Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)*, November 1996—This report focuses on mathematics achievement in 41 countries at the two grades with the largest proportion of 13-year-olds—the seventh and eighth grades in most countries. The report includes selected background information about students and teachers. Paperback, 176 pp. + 60 pp. Appendix, $30.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu. Also can be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

***Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)*, November 1996—This report focuses on science achievement in 41 countries at the two grades with the largest proportion of 13-year-olds—the seventh and eighth grades in most countries. The report includes selected background information about students and teachers. Paperback, 168 pp. + 62 pp. Appendix, $30.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu. Also can be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International

WHERE CAN I FIND A DETAILED INTERNATIONAL COMPARISON OF FOURTH-GRADE STUDENTS?

***Mathematics Achievement in the Elementary School Years: IEA's Third International Mathematics and Science Study (TIMSS)*, June 1997—This report focuses on mathematics achievement in 26 countries at the two grades with the largest proportion of 9-year-olds—the third and fourth grades in most countries. The report includes selected background information about students and teachers. Paperback. $20 (+ $7 shipping and handling, if international).**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu. Also can be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International

***Science Achievement in the Elementary School Years: IEA's Third International Mathematics and Science Study (TIMSS)*, June 1997—This report focuses on science achievement in 26 countries at the two grades with the largest proportion of 9-year-olds—the third and fourth grades in most countries. The report includes selected background informa-**

tion about students and teachers. Paperback. $20 (+ $7 shipping and handling, if international).

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu. Also can be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

HOW CAN I GET A FIRST HAND GLIMPSE OF ACTUAL CLASSROOM LESSONS IN THE UNITED STATES, GERMANY, AND JAPAN?

***VHS VIDEO Examples from the Eighth-Grade Mathematics Lessons in the United States, Japan, and Germany*—Actual footage of eighth-grade mathematics classes in Germany, the U.S., and Japan lets viewers see firsthand an abbreviated geometry and algebra lesson in each of three countries: Germany, Japan, and the United States. 72 minutes.**

To order, contact: National Center for Education Statistics, 555 New Jersey Ave., Suite #402A, NW, Washington, DC 20208; Telephone: (202) 219-1333; Fax: (202) 219-1736; E-mail: TIMSS@ed.gov.

***CD-ROM Video Examples from the TIMSS Videotape Classroom Study: Eighth-Grade Mathematics in Germany, Japan, and the United States*—Actual footage of eighth-grade mathematics classes lets viewers see first hand an abbreviated geometry and algebra lesson in each of three countries: Germany, Japan, and the United States.**

Minimum System Requirements:
IBM PC or 100 percent compatible, MS Windows ® (Windows 95 ® recommended), Pentium ® 90, 16 mb of RAM, 256 color SVGA or better, Double-speed or higher CD-ROM drive, Sound Card, or
Macintosh ® PowerPC 100 ® or 100 percent compatible System 7.5.3, 16 mb of RAM, 256-color or better, Netscape Navigator ® 3.0 with MPG plug-in Double-speed or higher CD-ROM drive.

To order, contact: National Education Data Resource Center, c/o Pinkerton Computer Consultants, Inc., 1900 N. Beauregard St., Suite 200, Alexandria, VA 22311-1722; Telephone: (703) 845-3151; Fax: (703) 820-7465; E-mail: ndrc@inet.ed.gov; Internet address: http://www.ed.gov/pubs/ncesprograms/elementary/others/ndrc.html

WHERE CAN I FIND OUT WHAT TIMSS HAS LEARNED ABOUT CURRICULUM?

***A Splintered Vision: An Analysis of U.S. Mathematics and Science Curricula*, 1997—This book enunciates the argument that mathematics and science curricula in U.S. schools suffer from a lack of focus. The authors contend that in their effort to canvas as many topics as possible, both teachers and textbook publishers fail to delve into the most important subjects with sufficient depth. 176 pp. Hardback ISBN: 0-7923-4440-5, $87; Paperback ISBN: 0-7923-4441-3, $49.**

To order, contact: Kluwer Academic Publishers Group, Order Department, P.O. Box 358, Accord Station, Hingham, MA 02018-0358; Telephone: (617) 871-6600; Fax (617) 871-6528; E-mail: kluwer@wkap.com; Internet: http://www.wkap.nl or http://ustimss.msu.edu/publicat.htm.

***Many Visions, Many Aims: Volume 1, A Cross-National Exploration of Curricular Intentions in School Mathematics*, 1997—An analysis of mathematics curriculum guides and textbooks in 50 countries. This report looks at the sequence and the topics covered from kindergarten through the end of secondary school, analyzed in a comparative framework. 286 pp. Hardback ISBN: 0-7923-4436-7, $120; Paperback ISBN: 0-7923-4437-5, $55.**

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***Characterizing Pedagogical Flow: An Investigation of Mathematics and Science Teaching in Six Countries*, 1996—Describes the results of the Study of Mathematics and Science Opportunity (SMSO) survey, which investigated curriculum content and instructional methods in France, Japan, Norway, Spain, Switzerland, and the United States using case studies in each participating country. 229 pp. Hardback ISBN: 07923-42720, $110; Paperback ISBN: 07923-42739, $49.**

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***TIMSS Monograph Series No. 3 Mathematics Textbooks: A Comparative Study of Grade 8 Texts*, 1995—Geoffrey Howson, Emeritus Professor of Mathematical Curriculum Studies at the University of Southhampton, England, examines eight mathematics textbooks for 13-year-olds for their pedagogical and philosophical similarities and differences. Texts are from the United States, the Netherlands, the United Kingdom, Norway, Spain, France, Switzerland, and Japan. Paperback, 96 pp. ISBN: 1-895766-03-6. $16.95.**

To order, contact: Pacific Educational Press, Faculty of Education, University of British Columbia, Vancouver, Canada V6T 1Z4; Telephone: (604) 822-5385; Fax: (604) 822-6603; E-mail: cedwards@interchange.ubc.ca.

WHERE CAN I FIND OUT MORE ABOUT THE METHODOLOGY OF TIMSS?

***Third International Mathematics and Science Study: Quality Assurance in Data Collection*, 1996—A report on the quality assurance program that ensured the comparability of results across participating countries. The program emphasized instrument translation and adaptation, sampling response rates, test administration and data collection, the reliability of the coding process, and the integrity of the database. 93 pp. + 91 pp. Appendix.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax (617) 552-8419; E-mail: timss@bc.edu; Also, may be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

***Third International Mathematics and Science Study: Technical Report, Volume 1 Design and Development*, 1996—This report describes the study, design, and development of TIMSS up to, but not including, the operational stage of main data collection. Paperback, 149 pp. + 40 pp. Appendix.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu; Also, may be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

***TIMSS Monograph Series No. 1 Curriculum Frameworks for Mathematics and Science*, 1993—This monograph explains the study's foci and its key first step – the development of the curriculum frameworks that served as the guide for designing the study's achievement tests. The frameworks are included in the appendices. Paperback, 102 pp. ISBN: 0-88865-090-6. $16.95.**

To order, contact: Pacific Educational Press, Faculty of Education, University of British Columbia, Vancouver, Canada V6T 1Z4. Telephone: (604) 822-5385. Fax: (604) 822-6603. E-mail: cedwards@interchange.ubc.ca.

***TIMSS Monograph Series No. 2 Research Questions and Study Design*, 1996—This monograph presents the study's research objectives along with discussions that include: the impact of prior studies on the design of TIMSS; how the research questions were derived from TIMSS' conceptual framework; and how the research questions and test items were tailored to meet the contexts of the participating countries. Paperback, 112 pp. ISBN: 1-895766-02-8. $17.95.**

To order, contact: Pacific Educational Press, Faculty of Education, University of British Columbia, Vancouver, Canada V6T 1Z4; Telephone: (604) 822-5385; Fax: (604) 822-6603; E-mail: cedwards@interchange.ubc.ca.

WHERE CAN I READ THE ACTUAL TEST ITEMS GIVEN TO STUDENTS?

***TIMSS Mathematics Items Released Set for Population 2 (Seventh and eighth grades)*—All publicly released items used to assess seventh- and eighth-grade students in the TIMSS study. Paperback, 142 pp. $20 (+ $5 shipping and handling, if international).**

***TIMSS Science Items Released Set for Population 2 (Seventh and eighth grades)*—All publicly released items used to assess seventh- and eighth-grade students in the TIMSS study. Paperback, 127 pp.**

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***TIMSS Mathematics Items Released Set for Population 1 (Third and fourth grades)*—All publicly released items used to assess third- and fourth-grade students in the TIMSS study. Paperback. $20 (+ $5 shipping and handling, if international).**

***TIMSS Science Items Released Set for Population 1 (Third and fourth grades)*—All publicly released items used to assess third- and fourth-grade students in the TIMSS study. Paperback. $20 (+ $5 shipping and handling, if international).**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu; Also, can be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International.

HOW CAN I FIND OUT MORE ABOUT EDUCATION IN VARIOUS TIMSS COUNTRIES?

***National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS*, 1997—Each participating country's education system is discussed in a separate chapter, considering geographic and economic influences, school governance, teacher education, curriculum, and other factors. Hardback, 423 pp. $75.**

To order, contact: Pacific Educational Press, Faculty of Education, University of British Columbia, Vancouver, Canada V6T 1Z4; Telephone: (604) 822-5385; Fax: (604) 822-6603; E-mail: cedwards@interchange.ubc.ca

APPENDIX 2
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APPENDIX 3
NATIONAL AVERAGE SCORES AND STANDARD ERRORS

The 95 percent "plus or minus" confidence interval around each nation's score is two times the standard error.

NATION	MATHEMATICS		SCIENCE	
	AVERAGE	STANDARD ERROR	AVERAGE	STANDARD ERROR
(AUSTRALIA)	546	3.1	562	2.9
(AUSTRIA)	559	3.1	565	3.3
CANADA	532	3.3	549	3.0
CYPRUS	502	3.1	475	3.3
CZECH REPUBLIC	567	3.3	557	3.1
ENGLAND	513	3.2	551	3.3
GREECE	492	4.4	497	4.1
HONG KONG	587	4.3	533	3.7
(HUNGARY)	548	3.7	532	3.4
ICELAND	474	2.7	505	3.3
IRAN, ISLAMIC REP.	429	4.0	416	3.9
IRELAND	550	3.4	539	3.3
(ISRAEL)	531	3.5	505	3.6
JAPAN	597	2.1	574	1.8
KOREA	611	2.1	597	1.9
(KUWAIT)	400	2.8	401	3.1
(LATVIA (LSS))	525	4.8	512	4.9
(NETHERLANDS)	577	3.4	557	3.1
NEW ZEALAND	499	4.3	531	4.9
NORWAY	502	3.0	530	3.6
PORTUGAL	475	3.5	480	4.0
SCOTLAND	520	3.9	536	4.2
SINGAPORE	625	5.3	547	5.0
(SLOVENIA)	552	3.2	546	3.3
(THAILAND)	490	4.7	473	4.9
UNITED STATES	545	3.0	565	3.1

MATHEMATICS INTERNATIONAL AVERAGE = 529

SCIENCE INTERNATIONAL AVERAGE = 524

Note: Nations not meeting international guidelines are shown in parentheses.

Source: Mullis et al. (1997) *Mathematics Achievement in the Primary School Years*. Table 1.1. Boston College: Chestnut Hill, MA and Martin et al. (1997) *Science Achievement in the Primary School Years*. Table 1.1. Boston College: Chestnut Hill, MA.

APPENDIX 4

SUMMARY OF NATIONAL DEVIATIONS FROM INTERNATIONAL STUDY GUIDELINES

Eleven of the 26 TIMSS countries experienced a more or less serious deviation from international guidelines for execution of the study. In 9 countries, the TIMSS International Study Center considered the deviations to be sufficiently serious to raise questions about the confidence to be placed in their scores. These 9 nations with major difficulties are noted with an asterisk.

***Australia**—Participation rate did not meet the international criterion of 75 percent of schools and students combined. Participation rate was 69 percent after replacements for refusals were substituted.

***Austria**—Participation rate did not meet either the international criterion of at least 50 percent participation by schools before replacement or 75 percent of schools and students combined. The initial participation rate was 49 percent for schools before replacement. Participation rate was 69 percent after replacements for refusals were substituted.

England—More than the international criterion of ten percent of schools and students were excused from the test for various reasons, with resulting coverage of 88 percent of the desired population. Participation rate of 83 percent of schools and students combined was achieved only after replacements for refusals were substituted.

***Hungary**—International guidelines for sampling procedures at the classroom level were not followed.

***Israel**—International guidelines for sampling procedures at the classroom level were not followed. The test was administered only in the Hebrew-speaking public school system. Participation rate did not meet either the international criterion of at least 50 percent participation by schools before replacement or 75 percent of schools and students combined. Israel tested only the fourth grade, in contrast to other nations that tested the two adjacent grades containing the most 9-year olds. Participation rate was 38 percent both before and after replacements for refusals were substituted.

***Kuwait**—International guidelines for sampling procedures at the classroom level were not followed. In contrast to other nations that tested two adjacent grades, Kuwait tested the fifth grade, which contained relatively few 9-year olds.

***Latvia** (LSS)—Test administered only in Latvian-speaking schools, with resulting coverage of 60 percent of the desired population. Because coverage fell below the international 65 percent population-coverage criterion, Latvia is designated (LSS) for Latvian-speaking schools.

***Netherlands**—Participation rate did not meet either the international criterion of at least 50 percent participation by schools before replacement or 75 percent of schools and students combined. The initial participation rate before replacement was 29 percent. Participation rate was 59 percent after replacements for refusals were substituted.

Scotland—Participation rate of 76 percent of schools and students combined was achieved only after replacements for refusals were substituted.

***Slovenia**—Students tested were older than those in other countries because Slovenia did not test the two grades with the most 9-year olds.

***Thailand**—International guidelines for sampling procedures at the classroom level were not followed. The sample included a high percentage of older students.

*U.S. Government Printing Office: 1997 - 428-502/70501

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